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THE AMERICAN MUSEUM JOURNAL

DEVOTED TO NATURAL HISTORY, EXPLORATION AND THE DEVELOPMENT OF PUBLIC EDUCATION THROUGH THE MUSEUM

December, 1916

VOLUME XVI, NUMBER 8

PUBLISHED MONTHLY FROM OCTOBER TO MAY INCLUSIVE, BY THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY. TERMS: ONE DOLLAR AND A HALF PER YEAR, TWENTY CENTS PER COPY. ENTERED AS SECOND-CLASS MATTER JANUARY 12, 1907, AT THE POST-OFFICE AT BOSTON, MASSACHUSETTS, ACT OF CONGRESS, JULY 16, 1894.

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MARY CYNTHIA DICKERSON, *Editor*

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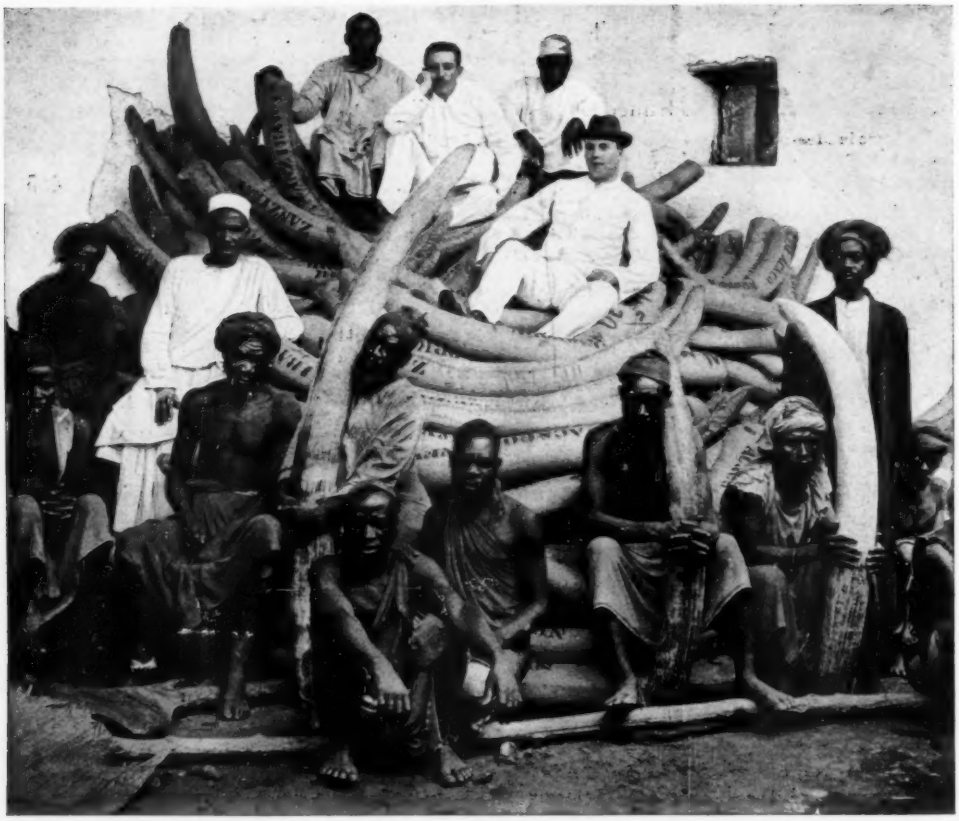


Courtesy of Doubleday, Page and Co.

ELEPHANT AND MAMMOTH IVORY

East African ivory, in the photograph above — a group of elephant tusks at Zanzibar
Fossil ivory from Siberia, below — a group of mammoth tusks from the Lena River

THE AMERICAN MUSEUM JOURNAL

VOLUME XVI DECEMBER, 1916 NUMBER 8

Kunz[1] on Ivory and the Elephant

By W. D. MATTHEW

THE chapters in Dr. Kunz's new book of most interest to students of natural history are those dealing with the sources of ivory, with modern elephants and with the evolution of the Proboscidea. It will be a surprise to many readers to learn how considerable a proportion of commercial ivory has been derived from the fossil mammoths of the islands north of Siberia, of the possibilities of Alaska as a source for (fossil) ivory — and one may add, the possibilities of future exploration in the Canadian Arctic islands.

The author describes at some length the habitat and characters of the modern Asiatic and African elephants, devotes a chapter to elephant hunting, and another to the elephant in history, citing numerous quaint descriptions and curious legends from classical and mediæval writers. Other chapters, no less interesting, deal with the sources and qualities of ivory and the methods of working it. There are numerous illustrations, a few of which are reproduced here, of notable carved pieces.

The chapter upon the evolution of the elephant is a brief account of the principal discoveries taken up in order of their geological age, and illustrating the successive stages in the evolution of elephants from primitive tapir-like animals of the early Tertiary. This interesting chapter in evolution is in large part a result of discoveries of the last few years. It has been briefly summarized by Andrews,[1] Lull,[2] Barbour,[3] and Matthew,[4] from whose accounts and illustrations Dr. Kunz has drawn, and to which he has added a number of recent discoveries. This chapter might very well, as a reviewer in the *New York Times* remarked, be extended into a book of itself. It is one of the most impressive records of the evolution of a race of animals.

The elephant is not only the largest of land animals but it is quite as singular and extraordinary in comparison with other quadrupeds as any of those strange extinct types which writers are so fond of calling "grotesque" and "bizarre." It stands off by itself in a separate order from all other living mammals, and the extreme specializations seen in its trunk, its tusks and grinding teeth, the proportions of its limbs and character of its feet, are as different from the ordinary run of quadrupeds as one could well

[1] Kunz, George F., *Ivory and the Elephant in Art, in Archæology, and in Science.* Doubleday Page & Co., Garden City, New York, 1916. Pp. i–xxvi, 1–527 with numerous illustrations.

[1] Andrews, Chas. W., 1903. *On the Evolution of the Proboscidea.* Phil. Trans. Roy. Soc., Vol. 196, pp. 93–118; 1908, Guide to the Elephants, Recent and Fossil etc. British Museum (Natural History), London.

[2] Lull, R. S., 1908. The Evolution of the Elephant. *Amer. Jour. Sci.*, Vol. XXV, March.

[3] Barbour, E. H., 1915. Prehistoric Elephants in the Morrill Collections. *Sunday State Journal*, Omaha, Jan. 3, 1915.

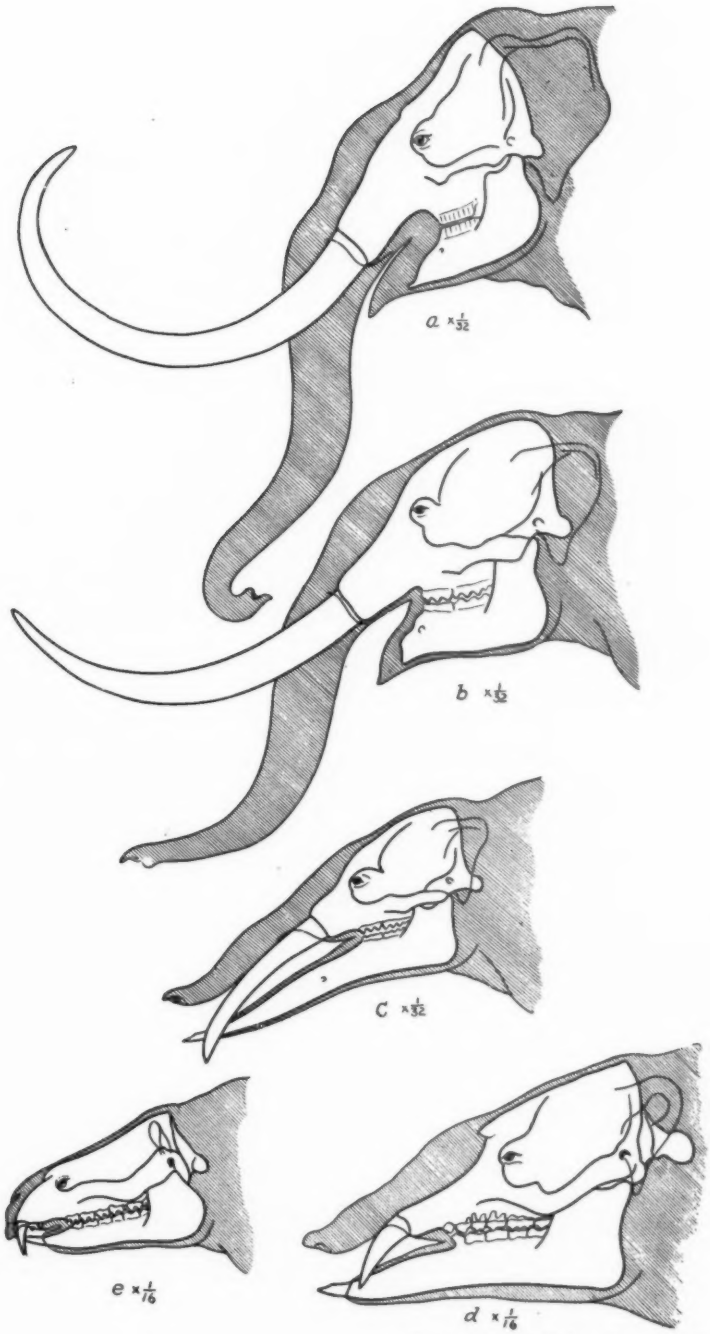
[4] Matthew, W. D., 1915. *Mammoths and Mastodons.* Amer. Museum Guide Leaflet No. 43, Nov. 1915; Climate and Evolution, Ann. N. Y. Acad. Sci., Vol. XXIV, pp. 171–318.

imagine. How well fitted they are to the animal's size and habits and how dexterously and intelligently he makes use of them is well known.

The gradual evolution of these structures from small and primitive beginings through many successive stages is illustrated in Dr. Kunz's account by the records and pictures of numerous fossil discoveries. Most of these are of recent years, and perhaps one reason why an extended monograph upon the evolution of the Proboscidea has not yet appeared is the rapid succession of these discoveries and the belief of palæontologists that we are upon the verge of new finds of importance that will settle some of the doubtful problems.

Bones of fossil elephants, on account of their size, were indeed noticed and mentioned by ancient writers. But they were thought to belong to "giants." This idea was not so absurd as it might seem. Probably very few of the finders had ever heard of an elephant, much less seen one. The long straight limb bones, the short wide vertebræ, especially of the neck, even perhaps the deep rounded jaws and the round high-vaulted skull, if these happened to be noticed, would seem to the mediæval mind, lacking our modern book knowledge but steeped in folk lore and pagan myths, to be exactly what the bones of giants or of ancient heroes of the north would be like. Picture to yourself, if you will, the laborers excavating for the foundations of some ancient castle or cathedral and coming across a buried mammoth skeleton deep beneath the surface. Most of the bones would crumble to dust, but several perhaps would hold together enough to enable them to be uncovered and some could be taken out more or less broken. Among them most probably would be ribs, one or two limb bones, a few centra of vertebræ, some pieces of the jaws. The teeth would almost surely go to pieces. The rounded surface of the skull might be exposed, but in attempting to lift it it would surely crumble into small fragments. Parts of the broad basin-like pelvis might be noticed, or of the wide short shoulder blade. All that workmen or interested visitors could see would be quite unlike any skeletons of horses or cattle or of any other quadrupeds that they knew about. Certainly therefore these bones couldn't belong to animals. But giants — everybody knew about giants. They were anywhere between twelve and thirty feet tall and enormously robust and powerful. Naturally their skeleton bones would be massive in proportion. The sexton, who has often dug up bones in the old churchyard, assures us that these are like them save for size and thickness. Father Roger, who has come down from the Abbey to look at the find, is greatly interested, and tells us about the giants of the Bible and how they were destroyed by the flood. Next Sunday he will preach about them. But old Walter, the gleeman, has another theory just as pat, and can recite no end of rhymes and tales about giants who lived right "round hereabouts" and not somewhere off in the Holy Land.

So we may imagine such a find talked about and disputed, and finally crystallizing into a legend current for years among the people roundabout, preserved perhaps by some casual reference in a book of sermons or a local chronicle, but chiefly serving to revive and confirm belief in the "giants of aforetime." They were no fools, these folk of the Middle Ages. They had plenty of shrewd native wit and observation. They could tell a hawk from a hernshaw just as well as you or I. But what else would you expect them to conclude



Courtesy of Doubleday, Page and Co.

STAGES IN THE EVOLUTION OF THE PROBOSCIDEA

Outlines of skull and head restored by Professor R. S. Lull.

a — *Elephant*, Pleistocene period, and still surviving in tropical regions; b — *Mastodon*, Pliocene and Pleistocene; c — *Trilophodon*, Miocene; d — *Palæomastodon*, Oligocene; e, *Mæritherium*, Eocene and Oligocene. The two lower figures are on a larger scale, one sixteenth natural size; the others are on a scale of one thirty-second

Courtesy of Doubleday, Page, and Co.

THE BERESOVKA MAMMOTH

Preserved from prehistoric times in the frozen tundra soil near the Beresovka River in northeastern Siberia. Discovered in 1900, and now mounted in the Petrograd Museum. The animal was covered during life by a heavy coat of black hair but only a small part of this has been preserved

from a find of this kind? What else should they have made out of it but "giants"? And who, after seeing such evidence with his own eyes, would afterward have any doubt of the inspiration of Father Roger's sermons or of the truthfulness of Walter's tales of chivalry?

Mediæval times and the mediæval faith passed away, and the skeptical "philosophe" of the seventeenth and eighteenth century sniffed at such evidence as this. If it wasn't altogether an old wives' fable, the fossil bones were remains of animals, elephants no doubt or rhinoceroses or some other big beast. But what were they doing in France and Germany — even in England? Fighting elephants of course, was the answer, brought over by the Romans or Carthaginians, or possibly some that had been brought for the games in the theaters. Haroun-al-Raschid, we recall, presented an elephant to Charlemagne, who took it with him on a campaign against the Danes. And so the matter rested for a while.

Finally Cuvier and other scientists of his day, making a really careful comparison between these fossil elephants and the living ones, showed to a very incredulous world that they were not quite the same as the living Indian or African elephants; that they were really extinct species, animals that had once lived but had completely disappeared from the earth, whether as a consequence of the Deluge, or of some other, perhaps earlier, convulsion of the earth.

For by this time the astronomers and geologists had succeeded in impressing upon the world the fact that after all this earth of ours was pretty old and had passed through a good deal of very ancient history before Adam appeared upon it — not less than forty thousand years, the great Buffon had estimated. Others were inclined to give even larger figures.

Thenceforward progress was rapid, both in opinion and in discovery, toward the views and the evidence that we hold today. A long succession of extinct faunas, each characterizing a particular epoch of the geological succession, was shown to exist, and it was not long before the evolutionists were searching this succession of faunas for evidence in support of their theories. At first this evidence seemed rather unsatisfactory, so much so that Huxley, when he first turned to it for a test of the truth of Darwinism, saw in the fossil record a strong argument against the theory. Later he changed his views and laid stress, as did Darwin, upon the imperfection of the record, as the explanation for its failure to produce the desired ancestral stages and missing links. As time went on it became possible through the progress of discovery to trace back the ancestry of many modern animals, and not a few of the missing links turned up, no longer missing.

So far as the elephants were concerned, their history had been traced back, thanks to discoveries in France and Germany, in Greece and in India, to the Miocene epoch of the age of mammals, and a fairly complete series of gradations had been shown to connect up the narrow-toothed mastodons of that age (*Mastodon angustidens*) with the mammoths and elephants. But there it stopped and until a few years ago nothing was known of the earlier history of the race. They appeared in Europe and in North America at that time — immigrants as it seemed from some other region, for no ancestral stages could be found in the older formations of either continent. They might have come from Asia perhaps, but Africa, the Dark Continent of palæontology, was for

was covered during life by a heavy coat of black hair but only a small part of this has been preserved
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various reasons favored by several writers (notably Henry Fairfield Osborn) as the original home of the race. And in 1902 researches in the early Tertiary formations of Egypt did in truth reveal two earlier stages in the evolution of the Proboscidea, clearly demonstrated as such by Dr. C. W. Andrews. The Argentine palæontologist, Ameghino, had, not long before, claimed that certain large animals which he had discovered in the older Tertiaries of Patagonia, *Pyrotherium* and its relatives, were the group from which the Proboscidea had sprung. This claim was not generally accepted; if true it would have indicated that the ancestors of the elephants came originally from South America. About the Egyptian *Palæomastodon*, however, there could be no question, and while the more primitive *Mœritherium* was not indeed a direct ancestor, it afforded a clue at least to what the still earlier stages in the evolution of the race were like.

Here then appeared to be proof of the African origin of the race; yet not as good proof as one might wish, for northern Egypt is very close to Asia, and its wild animals today are more those of southern Asia than of Africa. However, palæontologists with a theory to prove cannot afford to be too critical in sifting the evidence, and no one save the writer of this review has hesitated to accept the Ethiopian origin of the Proboscidea.[1]

Whether they came from Africa or not, the Proboscidea at all events spread widely over the northern continents during the later Tertiary, and even penetrated into South America, where (aside from the *Pyrotherium* which does not seem to have been especially related to them, although it developed tusks and grinding teeth curiously like the earlier Proboscidea) there were also true mastodons (*Dibelodon*) as far south as Argentina. The modern elephants, now limited to Central Africa and to India and Further India, are but a remnant of this formerly wide distribution, which lasted in the northern world almost to historic time and has left its records in the cave-drawings of prehistoric man and in the frozen carcasses preserved in the tundra soil of northern Siberia and Alaska. Of the most remarkable of these discoveries, the Beresovka mammoth, Dr. Kunz gives a fine photograph, which through his courtesy is reproduced here, along with a number of other illustrations from his book. The reader will find in the book, and in the various special authorities whom he cites, the most complete account at present available of what is known of the evolution of the elephant.

[1] The last word in palæontological discovery in the Old World has added a little to the evidence in favor of the theory; for a small collection of fossil mammals from the early Tertiary of Burma, while it had remains of very primitive ruminants, did not include any teeth of primitive Proboscidea, as one might hope to find if they had originated in southern Asia.

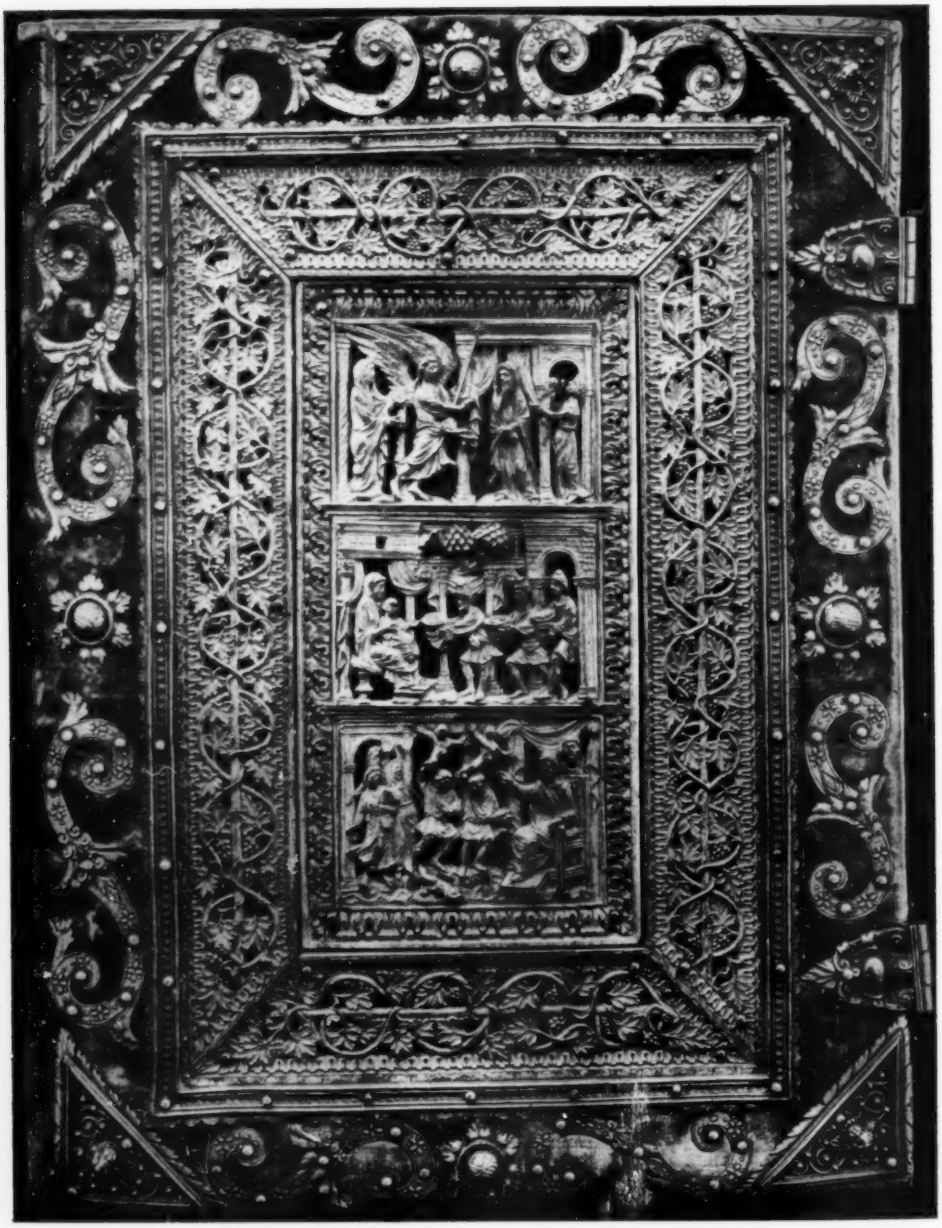
Courtesy of Doubleday, Page and Co.

IVORIES IN THE LOUVRE MUSEUM, PARIS

Carved ivory saddle-piece of the thirteenth century, representing Spanish or Sicilian art. The harp is an example of fourteenth century Flemish art

There has been in recent years rapid increase in the value of mediæval ivories. That they command such high prices today has led to many forgeries

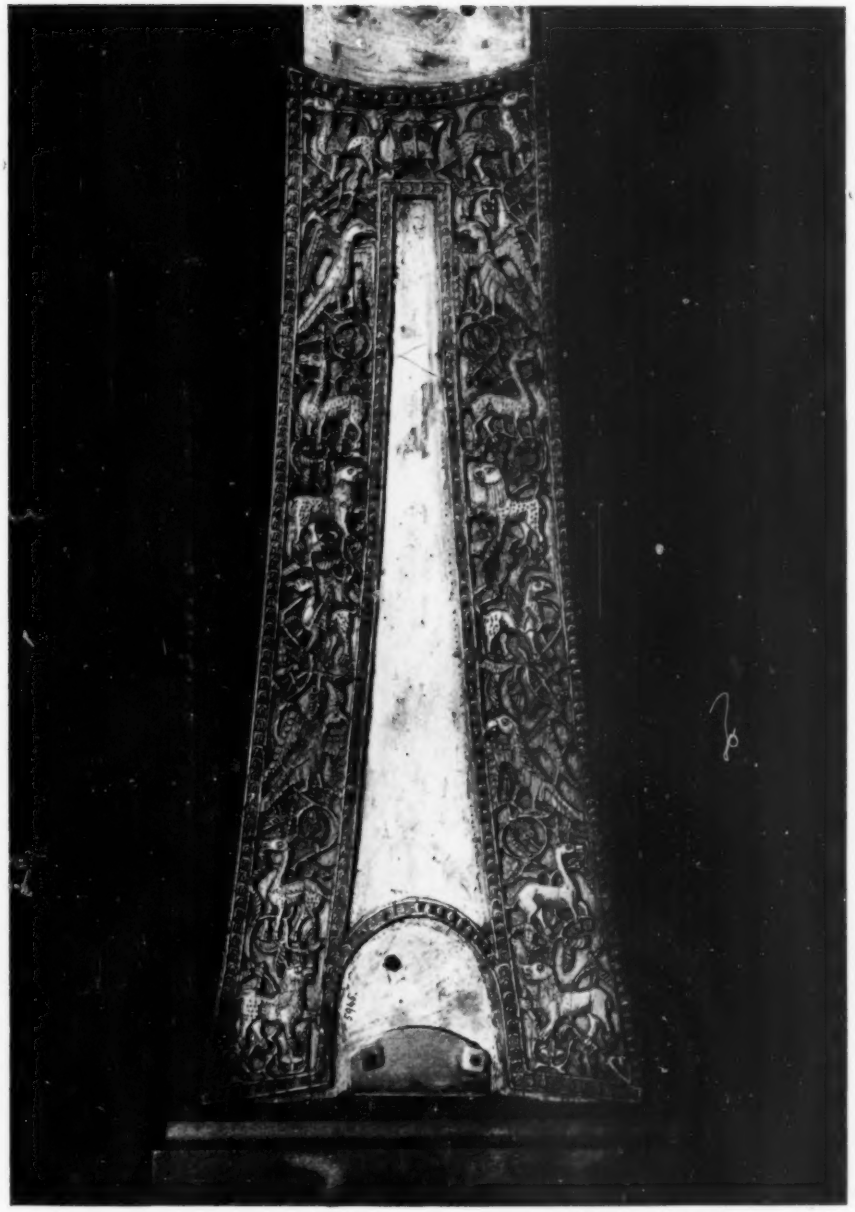
Dr. Kunz's book, *Ivory and the Elephant*, describes many ivories carved by artists of all countries, in ancient, mediæval, and modern times. It figures many of the most valuable pieces in the world's greatest collections of today. The following pages show photographs chosen from the book



Courtesy of Doubleday, Page and Co.

MEDIÆVAL BOOK COVER OF AN EVANGELIUM

Classic carving (thought possibly to date back to the sixth century) now in the Bibliothèque Nationale, Paris, having come from the Cathedral of Metz. In its serious treatment of the subjects of the three horizontal panels (Annunciation, Adoration of the Magi, and Massacre of the Innocents), it is typical of the Metz carvings as contrasted with those of Rheims (leading schools of Carolingian art). Many such valuable old book covers, with bindings of silver set with precious stones, have been greatly mutilated during revolutions in the past



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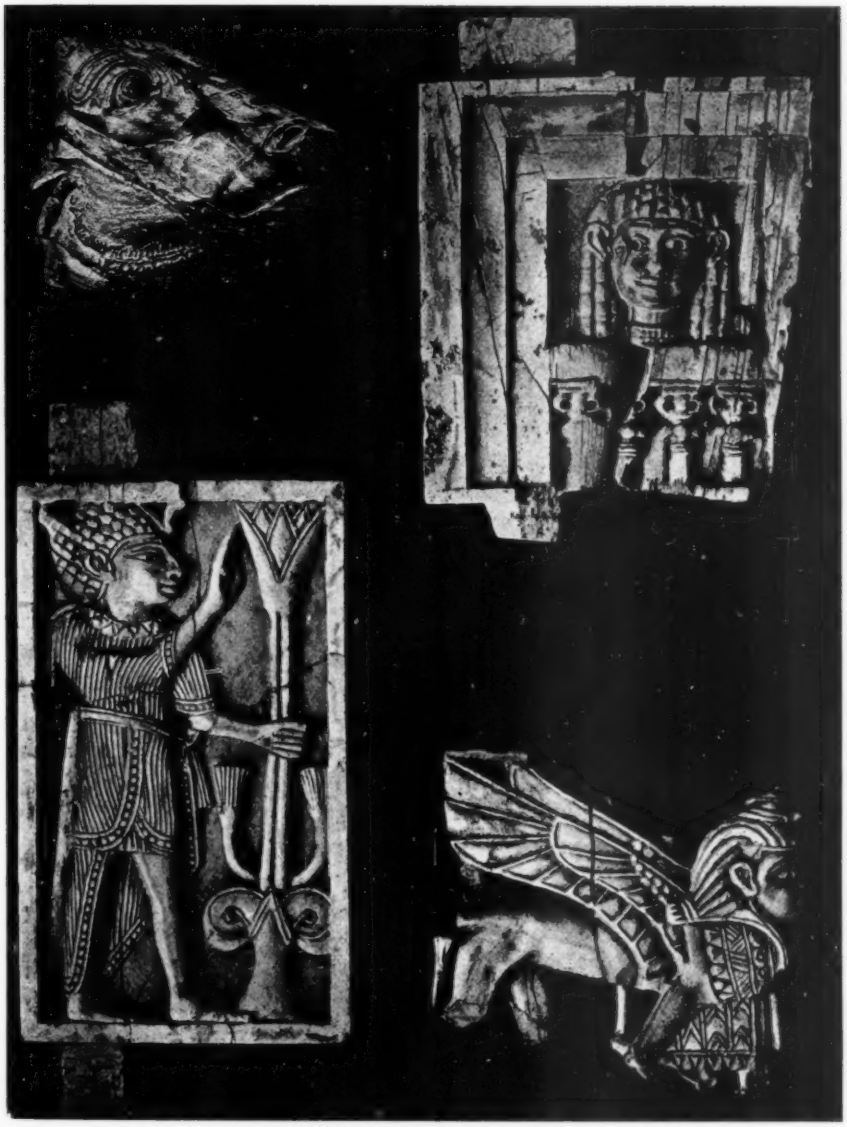
BIRD AND ANIMAL CARVING ON A CROSS

One of the arms of a cross now in the Louvre Museum. The work is by a Spanish artist of the twelfth century and shows Moorish influence. Among the various carved birds and animals are figures of the fabled griffin, a favorite subject of art in mediæval times

Courtesy of Doubleday, Page and Co.

ORIENTAL IVORY CARVING OF HIGH RANK

Finely wrought statuette of Ganesa, the elephant god of the Hindu Pantheon, now in the collection of Mr. Charles L. Freer, Detroit, Michigan. In niches of the base are carved figures, more or less obscure. Indian carvers greatly prefer African ivory to that of India or Ceylon, since it is of finer grain and is less likely to yellow with age



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ANCIENT ASSYRIAN CARVED IVORIES

They were found at Nimroud, with twenty-nine other pieces, in 1845, after having been buried in the earth twenty-eight centuries (since 980 B. C.) They are now valuable possessions of the British Museum. It could not be decided whether they were parts of a throne, or ornamented the walls of the palace chamber where they were found. The panel showing an Egyptian king holding a lotus is of especial interest. Assyrian ivory carving took its inspiration from Egypt

A SHOSHONE INDIAN SADDLE

Many Indian tribes were mounted a century before they were visited by white men, having obtained horses from other tribes in contact with the conquering Spaniards to the south (16th Century). This accounts for the similarity of Indian saddles, to one another and to the type in southern Europe and Asia and their total lack of resemblance to English saddles. The one shown above consists of two wooden side bars which rest on the back of the horse, a curious high pommel and cantel also of wood, between which is slung the seat (usually covered with a folded blanket or buffalo hide). The hook under the pommel head serves to suspend the seat and also to carry a lasso. The stirrups are of wood, and hang from the side bars by rawhide straps

American Indian Saddles

BORROWED, TOGETHER WITH OTHER FEATURES OF HORSE CULTURE FROM THE SPANISH COLONIZATION, IN THE FIRST HALF OF THE SIXTEENTH CENTURY

By CLARK WISSLER

IN THE North American Indian collections the American Museum visitor may see some curious saddles of native make. At first sight they appear as crude attempts to copy European saddles, but upon closer study prove themselves far more significant. Wrapped up in their histories is the whole story of bringing the horse to the New World and in part his domestication in the Old. Our idea of the western Indian is that of a horseman, but as far as we know, all the horse-using tribes were in existence and living much the same as now long before the horse came into their hands.

If we examine the fine old saddle in the Shoshone case of the Plains Indian hall, we find it quite different from our own. First of all it has two straight side bars that rest upon the back of the horse. Next we note that the high front (pommel) and back (cantel) are about the same shape. In fact the front of the saddle can be told only by a curious hornlike hook under the broad head of the pommel. This serves two purposes: supporting one end of a curious suspension seat and serving as a hanger for a lasso and a whip. To us such a saddle looks uncomfortable, but before mounting, the Indian places over the seat a folded buffalo robe or a blanket. These saddles are made of wood securely bound with buffalo hide, sewed on wet so that it may become tight by shrinking. In the Mills Catlin collection is a sketch showing a woman making a saddle. The binding and sewing were done by women and not infrequently the wood work as well.

There are several kinds of saddles in the cases, but upon examination all those having frames, or trees, will be found of the same general pattern. Their different appearance is due to the finish given their pommels and cantels. While the side bars are uniformly of wood and always similar in shape, the bows and cantels are often made of antler which being less pliable modifies the form.

Are they Indian inventions or were they copied from white people? This is one of the questions that arises as we look over these saddles. As they are so strikingly different from our own, we may be led to assume them original with the Indians. Yet the fact that all the various tribes have the same pattern should raise a suspicion that an external origin exists. In the first place we find among ourselves two kinds of saddles, the cowboy type and the type used on our streets. The former is used almost exclusively west of the Mississippi River, that is, in the region of the Indian saddle. Further, there is clearly a resemblance between the cowboy saddle and that of the Indian. But the Indian saddle is quite old, since exactly the same form is described by Lewis and Clark. One may then suspect that the cowboy saddle and the Indian saddle came from the same source. This, by the history of the case, can be no other than the Spanish American colonies. The saddle in use in the eastern United States is the

Sketch by Catlin in the Mills Collection of the American Museum

Indian saddles were made by the women, who bound the wooden parts together with buffalo hide, sewed on while wet so as to be tight on shrinking. Even the wooden parts were often made by the women. In the camp scene above, a saddle is shown staked to the ground while its rawhide cover dries and sets.

English type and was introduced by the English colonists. The history of the English saddle is well known and it is clearly differentiated from the saddle of southern Europe and Asia. The latter is quite like the cowboy saddle in all its essential features. It is therefore certain that the Indian saddles were borrowed from Spanish colonists.

One scarcely need be reminded that the Indian saddle is but one feature of horse culture and investigation shows that the whole of this culture, or the horse culture complex, was borrowed from the Spanish colonies. The historic details of how the Indians took up the horse are lost, but they must have done it quickly. The Spanish adventurer, De Soto, carried horses across the Mississippi in 1541 and at the same time an expedition under Coronado set out from Santa Fé, New Mexico, toward the same river. Both carried horses, some of which certainly escaped. In any event these expeditions demonstrated the value of the horse to the Indians. At that time many of the tribes were using dogs to transport baggage by means of a travois, examples of which may be seen in the Plains hall. We infer that when they saw the Spanish pack trains, they were struck by the superiority of the white man's "dog"; at least the Indian names for horse are derived from the words for

dog; thus, Dakota, *shunkawakan* (dog supernatural), and Blackfoot, *ponokamita* (elk-like dog).

The first exploration by La Salle (1682) revealed horse-using Indians on the lower Mississippi River and the first visitor to the Blackfoot of Canada in 1754 found the whole tribe mounted. It is therefore likely that many of the Plains tribes had horses one hundred years before they were visited by white men. The tribes in contact with the Spanish settlements drew their supply from the whites and in turn traded to their Indian neighbors or lost to them by theft. In this way horses could be rapidly carried to the tribes of the north, in fact some of the earliest explorers in western Canada occasionally found the Indians riding horses with Spanish brands.

Thus the study of the Indian saddle will lead one to the whole story of the horse in the New World and eventually to the Old World. The association of horse and man may be traced back to the dawn of culture in Europe. On the second floor of the Museum (directly above the Plains hall) is shown a rock carving of a wild horse from the cave men and on the wall a reproduction of a cave painting. Just where and when the horse was first tamed and ridden is not certain but everything points to the great plains of western Asia, where even today we find the most distinctive horse culture in the world. That the horse was developed by a non-agricultural people is clear from the almost universal Old World use of the ox with the plow and cart even to this day. The horse first came to the historic nations as a military aid and it was but recently that he displaced the ox as a draft animal.

We have thus far discussed the history of the horse in North America, but in the pampas of the southern continent this animal played a similar rôle. Although we have less data, it appears that the method of introduction and the rapidity of native adoption closely parallel the above. At least, we find the same general types of saddle, lasso, and other trappings.

Before they had horses the Indians used dogs, attaching them to the travois, a primitive vehicle consisting of two trailing poles bearing a net or cross bar for a load. The horses of the Spaniards no doubt seemed to the Indians very wonderful "dogs"; Indian names for a horse are derived from their words for dog

Photo by A. G. Mayer

A BLACK NORTHER ALONG THE BEACHES OFF ST. AUGUSTINE, FLORIDA

This is the winter battleground between the tropics and the north. In sudden fury after days of genial sun, cold air from far-off snow fields rushes wolflike into the region of the myrtle and the palm

The Gulf Stream off our Shores

By ALFRED GOLDSBOROUGH MAYER

Director of the Department of Marine Zoölogy, Carnegie Institution of Washington

IT IS on that vague borderland where things antagonistic blend that so much of charm and interest lies. Nor is science exempt from this general law for in the domain of blended interests, in physical chemistry, and biological medicine, research has enriched most notably the thought of the modern world. Nor is the naturalist free from this alluring fascination of the borderland, as of the forested river bank close to the desert sands, of the mountain peak where familiar things commingle with the strange ones of the tropics and wild strawberries mature beneath the shade of tree ferns.

Thus, of all our coasts, the waters of southern New England have most of this varied interest of a region of blended faunas. Here during early spring one finds among the melting ice vast swarms of floating creatures which have been driven far to the southward of their Arctic home by the cold northeasters of our winter.

In March and early April they mature with remarkable rapidity only to perish in the insufferably warm water as the season advances. Then, in August, their place is taken by rare and occasional wanderers from the tropics blown far from the blue region of the Gulf Stream to languish for a time in the chill waters off our shores.

Thus flitting over the hot sand and digging burrows into the beaches of southern Long Island, one finds the tiny young of the ghost crab, *Ocypoda*, the floating larvæ of which have made the long journey from the Carolinas or the Bahamas only to die as autumn advances.

Indeed, as is well known, the vast majority of the minute young of marine animals swim or float in the ocean during their early stages; and this applies to such sedentary creatures as sea anemones, corals, starfishes, oysters, clams, and even sponges. Thus these feebly-swimming, usually transparent larvæ may be carried by ocean currents for hundreds of miles during their several weeks of free life only to settle down, wholly change their appearance, and pass into the monotonous quietude of their adult days.

In this manner the tiny, pear-shaped larvæ of the corals, although only as large as pin heads, have been carried far to the northward to settle upon Bermuda, or to form the most northerly of the world's coral reefs off Beaufort, North Carolina.

Even in Great Peconic Bay, Long Island, we find wanderers from the tropics making themselves at home, at least two jellyfishes and a slender-armed serpent star, *Ophiura brevispina*, from the West Indies being of their number.

The "sea wasp" jellyfish, *Tamoya haplonema*, is a pale, livid creature whose relatives spend most of their lives in the depths of the sea commonly coming to the surface only to cast out their eggs or sperm. This Long Island medusa is rarely seen, for it gropes languidly over the bottom capturing fish and small shrimps by means of the stings inflicted by its four pale pink, whiplike tentacles. Its bell is cubical and about four inches high and near the pulsating margin, set each within a niche, there are four little knobs studded with eyes all looking

inward in the direction of the mouth. Thus if one may venture to ascribe sensations of any sort to a jellyfish, this one's chief pleasure seems to be in observing himself eat. It is found off the coast of Brazil; and Great Peconic Bay is at its northern limit.

It is remarkable how abundant and apparently well-conditioned an organism may be at the extreme limit of its range. Thus the scallop shell, *Pecten irradians*, is found by hundreds in Provincetown Harbor, Cape Cod, but practically vanishes north of this point. Also on Smith Island, Cape Fear, North Carolina, we find a flourishing grove of palmetto palms, the most northerly of their species.

There is something pathetic in Nature's wholesale ruthless destruction of all who transgress her laws, and it is with a pitying eye that one finds in our chilling sea the iridescent crest and float of the Portuguese man-of-war, *Physalia*, a beautiful glass model of which may be seen in the American Museum. This creature appears only occasionally off our coast but then nearly always in swarms as is commonly the case with the floating animals of the sea. The *Physalia* when well grown must always remain floating with its numerous tentacles stretched far out like slender ribbons edged with rows of purple beads, and woe betide any unwary fish which touches their stings. The struggling, more than half-paralyzed victim is drawn quickly within reach of the hundreds of greedy mouths which fasten like suckers upon it. A creature of the wide and open sea is the *Physalia* and little is known of its development excepting that when very young it can discharge the gas from its then oval float and sink with its single tentacle into the ocean's depths. For a long time it was thought that all of our physalias were males, but recently the female organs have been discovered and we now know that the creature is hermaphroditic. In the Pacific there is a smaller species which has one large and many small tentacles. Our *Physalia* passes through such a stage but eventually acquires many large tentacles. Over the wide region of the tropical Atlantic this beautiful creature may be seen flashing its iridescent hues above the deep blue of the sea, drifting ceaselessly, unharmed by hurricanes or calm, and heedless of the sunshine or the night; while gliding languidly in and out among the tangles of its tentacles, fishes of purple and silver hues find their refuge and their food.

Rivaling the *Physalia* in interest but smaller and more uniformly blue are its two floating relatives, *Velella* and *Porpita*. *Velella* is a parallelogram-shaped animal, about three inches long and an inch wide, while in the center there is an oval chitinous float which extends upward in a sail-like crest. *Porpita* is much smaller and is circular and has no crest. In the Gulf Stream one sometimes finds swarms composed of such myriads of these creatures that the water is dotted with purple-blue for many square miles. There are interesting things respecting the habits of *Velella* and *Porpita*, among which is the fact that they are always infested with great numbers of minute, rounded, yellow-colored plant cells. Even the youngest larvæ of these creatures have these plant cells which by giving off oxygen and consuming carbonic acid must aid the vital processes of their host.

Blue is the prevailing color of the upper surfaces of these floating animals of the surface waters of the tropics, and the remarkable drifting snail, *Janthina*, is no exception to the rule as it exudes a bubble like raft which floats both it and

Photo by A. G. Mayer

MORNING MIST AMONG THE PALMETTOS, NEAR THE MOUTH OF ST. JOHN'S RIVER, FLORIDA

The warm air over the Gulf Stream has drifted in over the cold shore waters and is chilled into raw mist along the beaches

its cluster of eggs upon the surface of the sea. These and many other smaller creatures are occasionally cast up upon our shores by summer storms, but their destruction along our coast is as nothing compared with the thousands of dried floats of *Velella* and *Porpita* and the broken shells of *Janthina* which often lie heaped in drifts over southern beaches.

It is curious and indeed largely unexplained, that floating animals tend to appear in swarms. No matter how rare the creature, if the townet reveals one, others will almost certainly be caught in its near neighborhood.

I have seen a swarm of the brown-rimmed southern jellyfish, *Stomolophus*, in which individuals were rarely more than ten feet apart, yet for over sixty miles we passed constantly through them. But swarms of creatures in the tropics are as little in comparison with the vast numbers of individuals which gather in the frigid seas. In cold waters one finds many individuals but few species, whereas in the tropics the species are many and the individuals relatively few and far between.

Everywhere protection is the keynote of their coloration for in the depths where no red light can penetrate, the animals are of the peculiar "deep-sea red"; for being red in the absence of red causes them to appear black in the dimly lighted regions they inhabit. Similarly, the backs of floating animals, especially in the blue waters of the tropics, are blue, while on their sides they shade through silver into glistening white on the underparts, in accordance with Abbott Thayer's law of protective coloration.

It is to that vast, unsteady, but dominant swirl of tropical surface waters into the north Atlantic that we owe the occasional presence of a few West Indian creatures along our northern New England shores; but at least a hundred to one of our shore animals are those of the cold gray-green waters which creep slowly down hugging closely to our beaches all the long way from the chill, fog-haunted region of Nova Scotia to the sparkling strand of Florida. It is this long gray streak of cold water clinging to our coast that gives the raw chill to winds blowing over the ocean upon our shores; and the prevailing northeast gales from November to April drive the cold waters steadily southward so that Arctic marine animals flourish at this season off the New Jersey coast. Even Florida is not exempt, as all who have experienced the rush of a black "norther" along her shores must know.

This cold shore water of our eastern coast has commonly been called the "Arctic current," but this is a popular fallacy for the true Arctic current is of clear green water which sheers out into the open Atlantic from the eastern shores of Newfoundland, bearing icebergs within it far out into the mid-Atlantic, never down our New England coast.

Through the narrow passage, only forty-four miles in width, between the Bahamas and Florida, there pours the true Gulf Stream flowing northward at a rate of full three miles an hour. Although often checked by northerly winds or accelerated by favoring breezes, this vast body of water rushes as a mighty river out into the free expanse of the ocean to be lost in the wide world-eddy that passes northward between our shores and Bermuda, to bend ever eastward and finally when less than half way across the Atlantic to die into a mere drift borne still eastward by the prevailing winds to the shores of grateful Europe.

Along the coast of Florida, one often

sees the edge of the Gulf Stream clear cut in deep blue against the dull gray-green of the shore drift, and myriads of little swirls and eddies mark the border line between the two opposing currents. At one stroke of the oars, one leaves the barren shore drift and enters the tropical ocean with hundreds of heat-loving creatures swimming hither and to through the genial limpid element that is bearing them remorselessly northward to perish in the "roaring furies" of the Atlantic.

Off Key West, or Miami, the Gulf Stream flows within a few hundred yards of the outer edges of the coral reefs. At Cape Hatteras it may be ten miles or more off shore, and beyond this point it wanders with many variations as a wide surface eddy farther and farther from our shores to lose itself in the midst of the Atlantic.

Often one finds temporary whirls or counter currents in its meandering uncertain course, and none can predict its movements except in the most general way; so that some sea captains who constantly sail over it, to and from the West Indies, have actually lost faith in the existence of the Gulf Stream. The popular conception of it as a "mighty river" flowing over the ocean is quite erroneous, for ocean currents are more of the nature of eddies or swirls, those affecting the surface being counterbalanced by others in the depths. Thus the Gulf Stream is a surface eddy due to the pressure and friction of the prevailing tropical winds as they pass over the ocean from colder regions toward the heat equator. These tropical trade winds blow as young gales with proverbial constancy toward the southwest in the northern, and toward the northwest in the southern hemisphere. Thus their westerly trend imparts a similar movement to the surface waters of the equatorial region. Were the Isthmus of Panama now widely open, as it probably was long ago in the age of the reptiles, the equatorial current would surely rush through the gap to continue its course across the vast expanse of the Pacific. In our day, however, the great, deep, shut-in basin of the Gulf of Mexico acts as a trap into which the waters are forced through the wide Straits of Yucatan, and out of which they must rush through the narrow channel of the Straits of Florida, to travel along our coast toward Cape Hatteras, and thence outward into the Atlantic.

Just why it should desert our shores beyond Hatteras and swerve ever more and more toward the eastward may not be so clear until we consider that any body moving either north or south tends to maintain its direction in space independent of the rotation of the earth. Thus the trade wind of the northern hemisphere tends to go straight southward toward the equator, but the earth rotating from west to east passes under it as the wind blows down from the slowly moving northern latitudes to the more rapidly moving equator. Hence the wind is forced into a more and more westerly direction.

In fact, every body moving north or south in the northern hemisphere is forced by the earth's rotation toward the right, and in the southern hemisphere toward the left; and this applies to the course of storms or air currents as well as to water currents. Thus we see why the cold northerly current must cling constantly to our eastern coast, while the Gulf Stream in its northerly trend must go far out into the Atlantic — both currents tending always toward the right.

Moreover, we know from recent researches such as those of Harris upon the tides, or of the Norwegian steamer

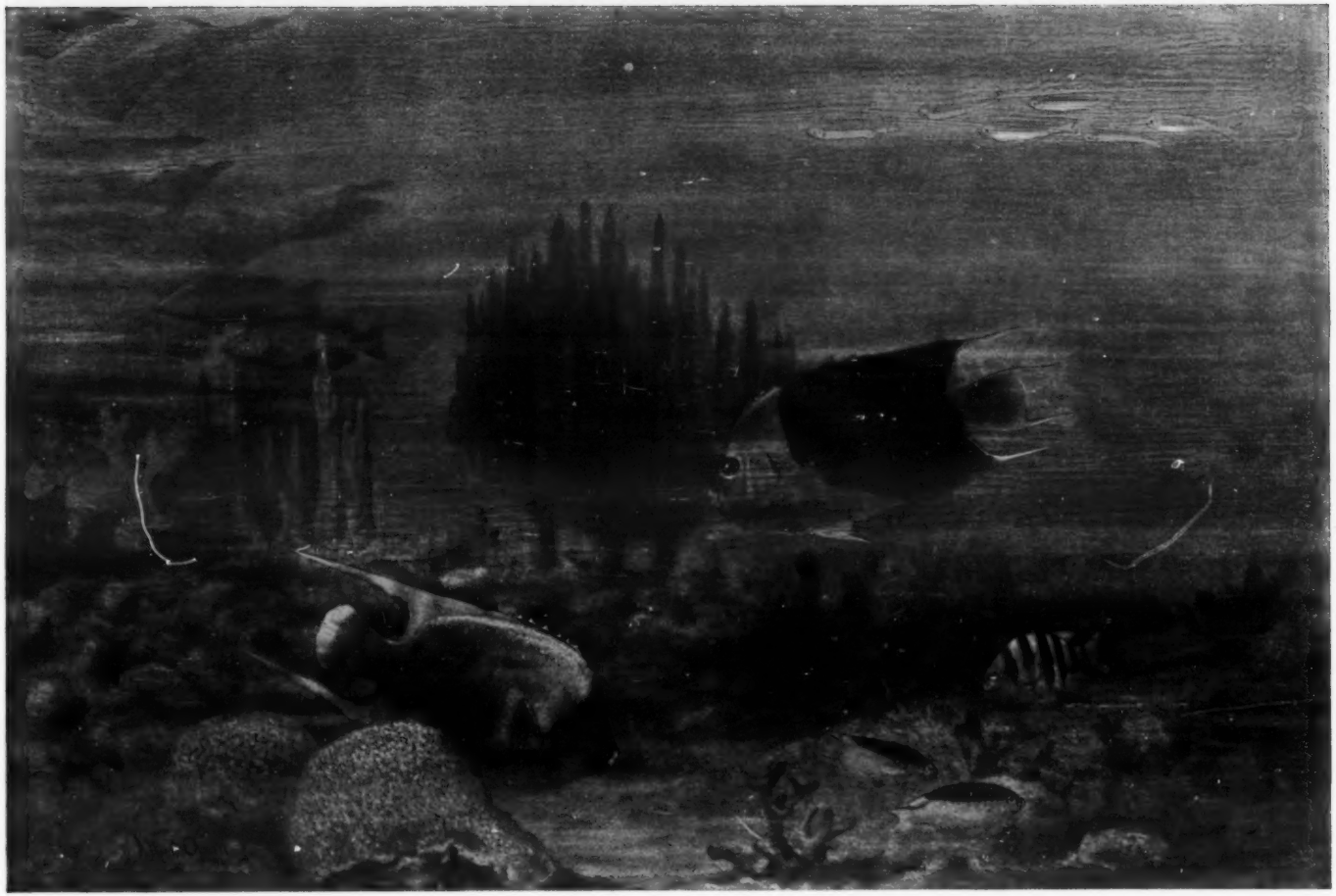
"Michael Sars" upon currents, that the ocean is more elastic, so to speak, than we had supposed. Thus it breaks up into "regions of vibration" in its tidal movements. For example, the Mediterranean is cut into two distinct tidal areas by the narrow channel, blocked by Sicily, between Italy and Africa, and we now know that over the ocean there are many more or less independent tidal regions bounded by chains of islands or embayed by continental shores, and tidal waves may affect not only the surface but be detected a thousand feet or more beneath. Thus a surface current flowing northward must be counterbalanced by a deep one flowing southward, and this is why the cold Arctic waters wander toward the tropics along the deep-lying ocean floor, the temperature at eighteen thousand feet under the equator being only slightly above the freezing point.

Thus it is that the floors of the deep open oceans are covered with cold polar water and the deep sea animals off Nantucket are strikingly like those off Ceylon, while similarly, the surface creatures of the West Indies bear a close general resemblance to those of the tropical Pacific. Indeed, so important a factor is temperature in the control of animal life that probably not one in a thousand of the West Indian species ranges north of Cape Cod.

Thus the West Indian creatures which appear along our shores in summer are children of the surface drift whose lives lie at the mercy of the current and the wind as they ceaselessly float eastward across the tropical Atlantic and then through the wide sweep of the great ocean eddy to be returned to the shores of Africa, thence outward from the peril of the beaches to the free and open sea.

Photo by A. G. Mayer

No forests are more somber than stately live oaks, heavy with their burden of "tree moss." Yet curiously this plant is not a moss, but is a relative of the pineapple. It flourishes in the damp warm air of our southern coast from Florida to South Carolina, and will grow upon telegraph wires quite as readily as upon live oaks



CORAL REEF FISHES

In the center, Bermuda angel fish (*Angelichthys isabelita*) yellow and blue, and rock beauty (*Holocanthus tricolor*) yellow and black, family Chætodontidæ; lower right, sergeant fish (*Abudefduf saxatilis*) banded with black, and beau gregory (*Eupomacentrus leucostictus*) blue and yellow, family Pomacentridæ; upper left, red parrot fish (*Sparisoma abildgaardi*), to show the striking and varied colors flaunted with impunity by fishes which seldom venture far from the security of the reef. Upper right, a school of *Atherina*, small free-swimming, non-reef fishes, whose safety depends on being inconspicuous

The Problem of Bright-colored Fishes[1]

By JOHN TREADWELL NICHOLS

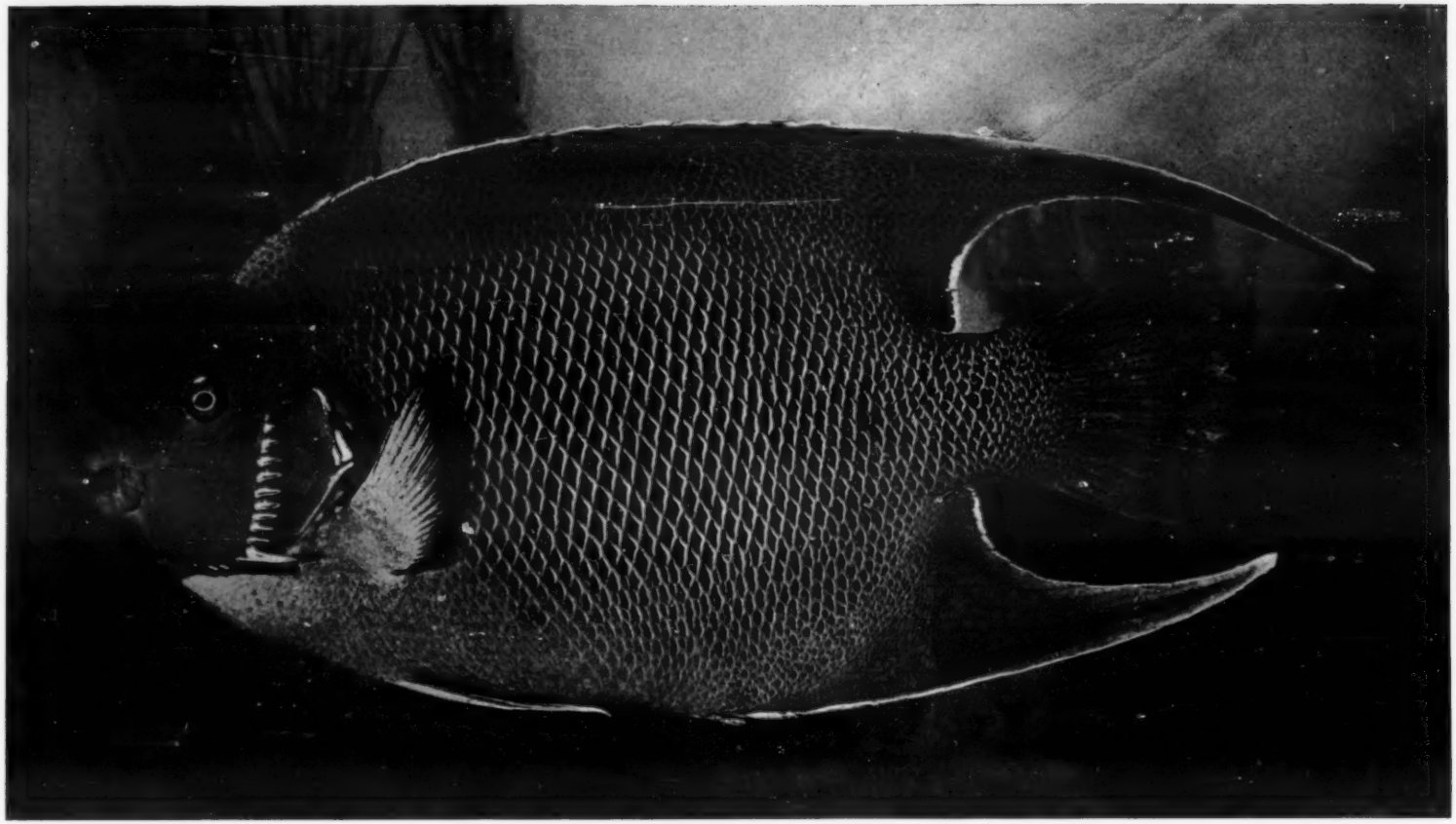
THE colors of the majority of northern fishes are rather dull. Many species found about tropical reefs, on the other hand, are very highly colored, with bold or bizarre markings. The Bermudas, and Santa Catalina Island in California, are famous for such brightly colored fishes, and tourists admire them at these places from specially constructed glass-bottomed boats. Looking through the glass, vision is not hampered by the glare of the ruffled surface, and one can look down through the limpid oceanic water to where the fishes ply in and out among the picturesque heads of coral and other forms of fixed marine life at the bottom. Living fishes of bright color have been very successfully installed by the New York Aquarium, in tanks where they are admired by crowds of people who otherwise would not have the opportunity to enjoy them. Quite apart from their popular interest, the gaudy colors of such fishes have long appealed to the naturalist; they have been the subject of considerable serious study, and various theories have been advanced to explain them.

Wallace claimed that their bright colors matched the brilliant corals and seaweeds of the reef, and rendered the fish inconspicuous in the same way that duller colors are known to conceal species found in less variegated environments, and for years this explanation was widely accepted. It seems however that he exaggerated the color of the reef background, which is as a whole of a rather uniform gray or green tone with only here and there bright areas. The bold colors of certain stinging or distasteful insects are explained as a warning to possible enemies, which would be expected more readily to learn to recognize and avoid such species when boldly colored. Professor Reighard of the University of Michigan has done careful experimental work on tropical fishes to determine whether they might be classed in the same category with warningly colored insects, and has obtained conclusive proof that their colors are not of this character. Messrs. Abbott H. and Gerald H. Thayer, in an eloquent plea for the universality of concealing coloration, follow Wallace in the belief that the colors of reef fishes actually do blend with their environment and render them inconspicuous, although at first thought this does not seem to be the case. The work of these gentlemen has especial interest as it approaches the problem with the professional artist's knowledge of color values. Dr. Charles H. Townsend of the New York Aquarium has called attention to the striking color changes which certain species undergo. Such changes often make for the concealment of the fishes, but do not prove that the bright colors when present have also a concealing value. Often a single fish has color patterns so different as to give the impression of more than one distinct species, but to anyone familiar with the different fishes, the bright livery of each is diagnostic.

The center of abundance of aquatic life is in the sea close to the shore. Here exist many more varieties of fishes than landward in restricted fresh waters, or

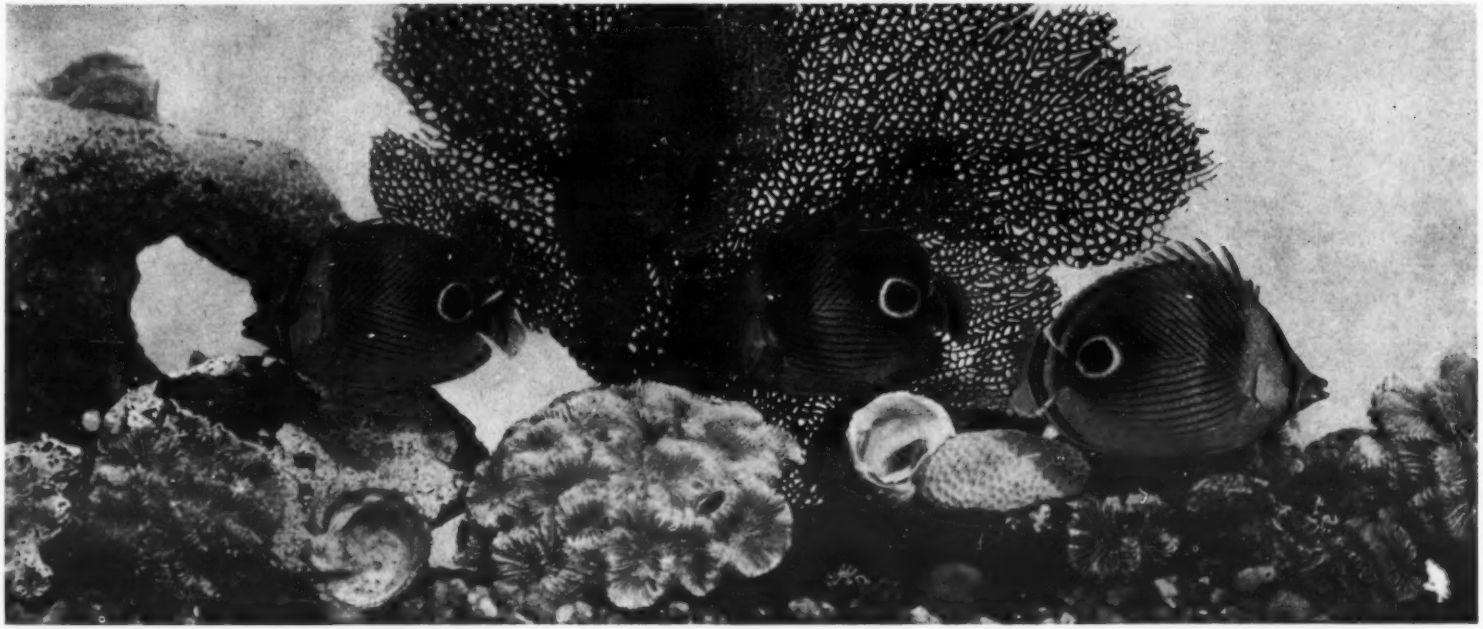
[1] Photographs by Mr. E. R. Sanborn of living fishes at the New York Aquarium, and used in the JOURNAL through the courtesy of the New York Zoölogical Society.

by fishes which seldom venture far from the security of the reef. Upper right, a school of *Atherina*, small free-swimming, non-reef fishes, whose safety depends on being inconspicuous



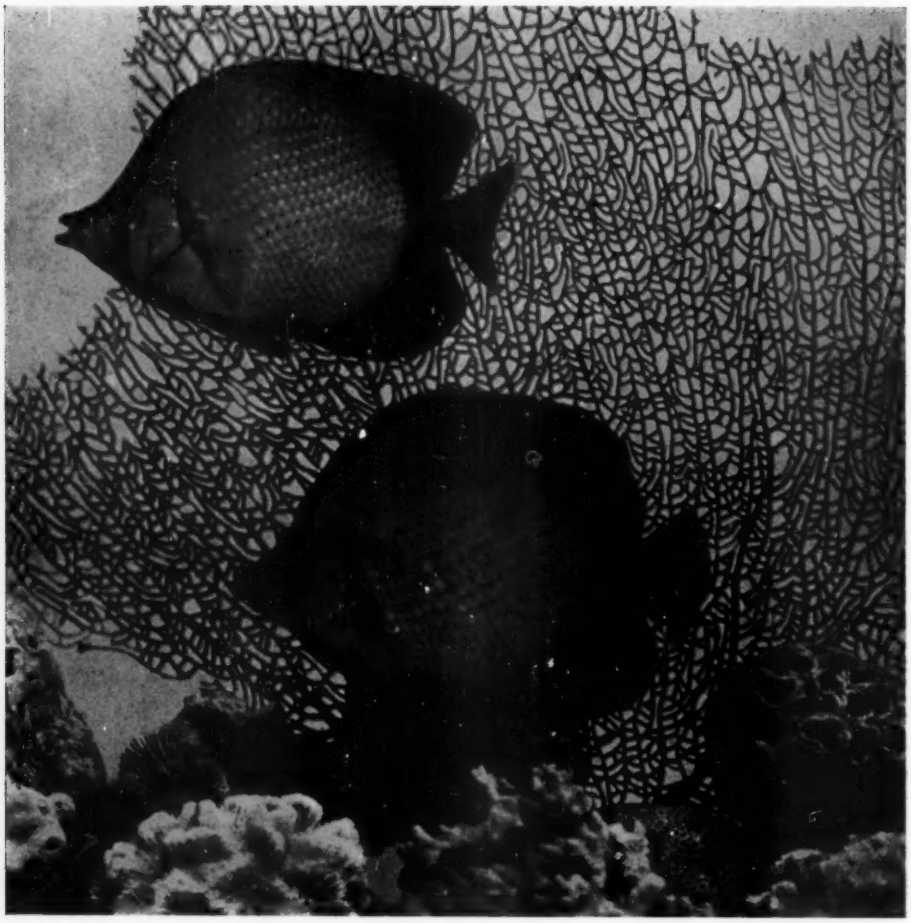
ANGEL FISH OF THE WESTERN ATLANTIC

This fish (*Angelichthys isabelita*), much admired by visitors to the Bermudas, is brownish-gray in general color, but the nape, breast, spines of head, outer margins of elongate fins and part of the pectoral fin are blue, while parts of the pectoral and caudal fins, the center of the streamers and the ventral fin are yellow. The New York Aquarium has recently had on exhibition three angel fishes unlike in color and with slight structural differences, all from Key West, *Angelichthys isabelita*, *A. ciliaris*, and *A. townsendi*, the latter new to science. These fish abound about the coral reefs of the western Atlantic



THE BUTTERFLY FISH *CHÆTODON CAPISTRATUS*

The bold eyelike spots near the tail have given this species the name "four-eyed fish." It is very active, and with other butterfly fishes is plentiful near tropical coral reefs. Its striking markings are in strong contrast with the environment



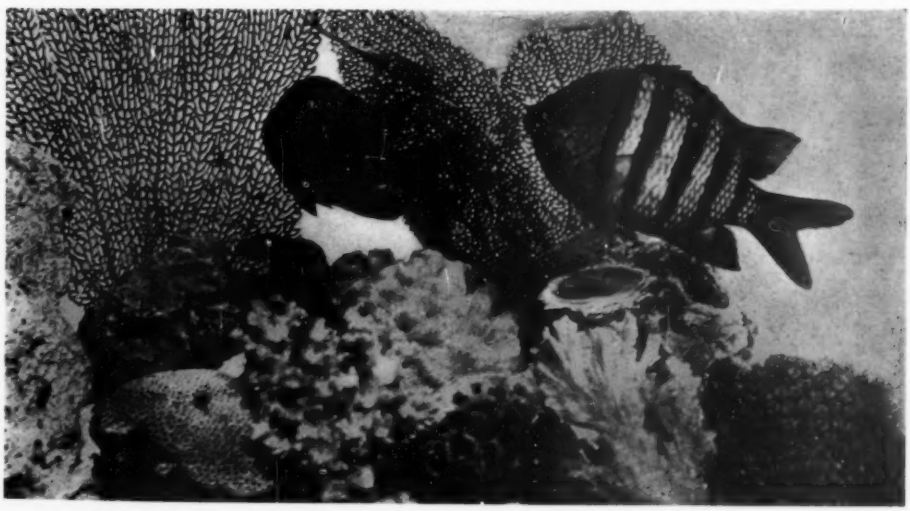
One of the commonest butterfly fishes in the West Indies (*Chætodon ocellatus*), and the one most frequently drifted northward by the Gulf Stream at the end of the summer. It has been found in the vicinity of New York City in October. The specific name is a misnomer, as the species is preëminent among butterfly fish for its lack of "ocelli" or eye spots

seaward in the vast monotonous stretches of the ocean's floor or depths. We find the very greatest number of forms along the shores toward the equator, where in perennial summer conditions about the tropical reefs, kinds have arisen and multiplied to take advantage of every slightest phase of the peculiarly favorable and practically unchanging environment. Many related species exist together in the same waters.

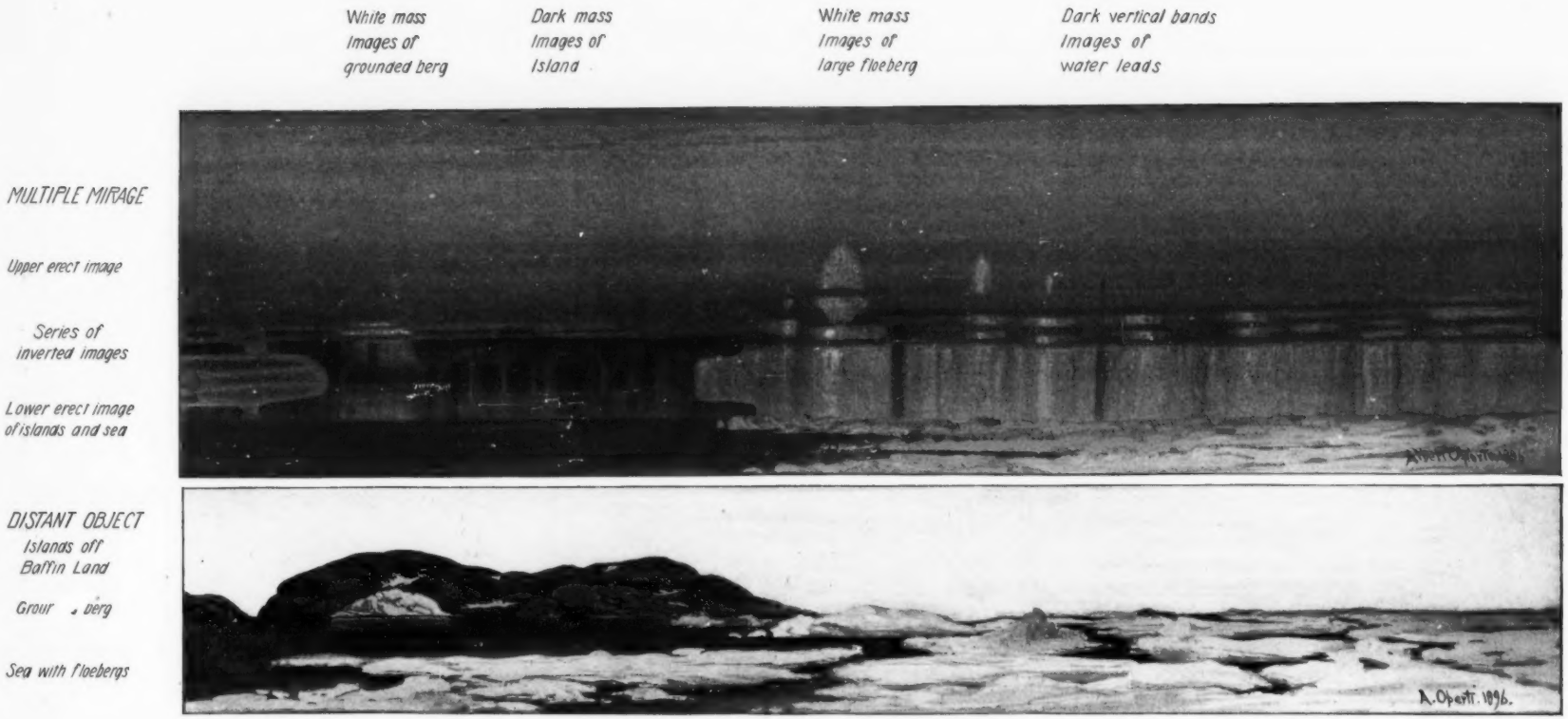
The West Indian fish fauna, for instance, is rich in bright-colored parrot fish. Among the common or widely distributed species are the red parrot fish, *Sparisoma abildgaardi*, with fins and lower surface bright cherry red; *Sparisoma chrysopterum*, bright greenish blue, with fins largely brick red; *Sparisoma viride*, deep blue with yellowish shades, the tail fin with a yellow crescent; *Scarus vetula*, which is dark sky blue with red stripes on the head and fins; *Scarus cæruleus*, a deep uniform blue; *Pseudoscarus guacamaia*, which is green. All the above are parrot fish.

In the same region among the Pomacentrids, the sergeant major, *Abudefduf saxatilis*, is everywhere common, a yellow fish with vertical black cross bars. At Porto Rico another *Abudefduf* occurs commonly with it, which may be recognized by an equally bold but quite dissimilar color pattern. Unfortunately, the writer in a recent visit to that island was able to obtain only the very young of the second species, the identity of which cannot be satisfactorily determined; but larger ones were seen. Relatives of *Abudefduf*, one or more brightly colored members of the genus *Eupomacentrus*, are always present. The commonest one has striking yellow and blue color contrasts. Several butterfly fish (*Chætodon*) are characteristic of the same waters, readily differentiated from one another by the bold bars and eye-like spots which characterize their various patterns; and among the most striking of our American fishes are members of the same family, the long-finned blue and yellow angel fish *Angelichthys*, and *Holacanthus tricolor*, bright yellow or orange with a jet black center. Three species of blue angel fish (*Angelichthys*), recognizable by color differences, have recently been found at Key West.

In the writer's opinion *it is of value to each species to possess some distinctive badge or uniform separating it from its neighbors*, and this accounts in part for the bright colors. For the rest, the security which the innumerable crags and crevices of the reef afford, makes it possible for reef fishes to flaunt in safety banners which, if shown in the open, would but court destruction. Professor Reighard has called attention to this latter fact in speaking of the bright colors of reef fishes as "immunity coloration." The case is not unlike that of gaudy tropical birds which can vanish among the dense foliage whenever their splendor attracts unfavorable notice. In conclusion, the bright colors of reef fishes are believed to be of value to them for differentiation and recognition purposes. As in the past, it is easy to advance theories to explain, but it still remains for any one to gather sufficient proof on the subject to convince not only himself, but also others. This would seem an interesting field for some investigator at a marine biological station.



The sergeant fish (*Abudefduf saxatilis*) is readily recognized on the reef by its bold black and yellow bars, and is one of the most abundant tropical fishes. The very young, no larger than one's finger nail, and looking precisely like the adults, can be found in numbers swimming in shallow rock pools left by the tide



MULTIPLE MIRAGE IN THE ARCTIC

This mirage, with its strange dark object at the left, was seen off Baffin Land and sketched by Mr. Albert Operti, artist with the Peary expedition of 1896. The mirage was seen at 2.30 P. M., when there was a bright sunlit sky. The dark island, with grounded ice and floebergs, imaged in the mirage, was not visible until the ship had proceeded fifteen miles farther on her way. *Drawn by Albert Operti*

A Perplexing Phenomenon — Mirage

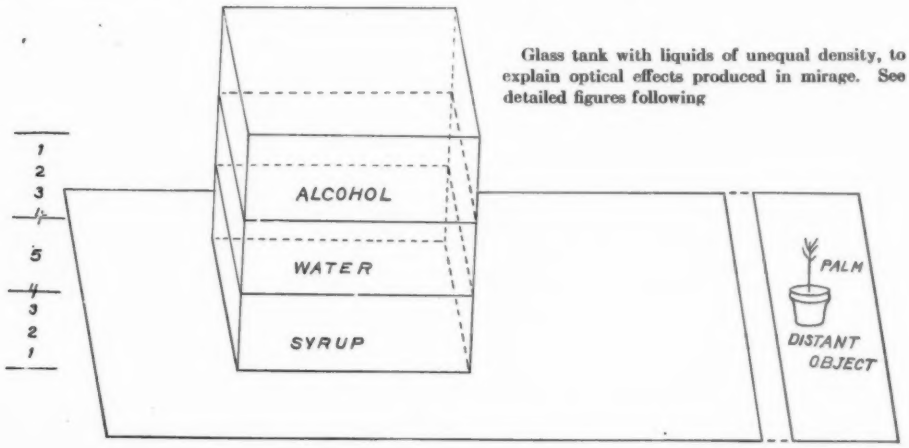
By CHESTER A. REEDS

THE leader of the Crocker Land Expedition, Mr. Donald B. MacMillan, states in *Harper's Magazine* for November, 1915, that Peary's "Crocker Land" is a mirage. Should we accept the idea that Crocker Land is a mirage, we must bear in mind that to produce the effect of "immense lands with hills, valleys and snow-capped peaks" where none exists, there must be objects on the surface of the earth, and certain conditions within the air, which serve to give rise to such illusions. As the immense productions developed in a mirage out of comparatively small objects are most extraordinary, it is not surprising that mirages occur only under abnormal atmospheric conditions. It is essential that layers of air of unequal density arise and that light waves which traverse them be bent unevenly, so that magnified, distorted, transported and inverted images of distant objects be produced. Mirage is thus a strange optical phenomenon which sometimes entertains and helps men, and sometimes leads men astray.

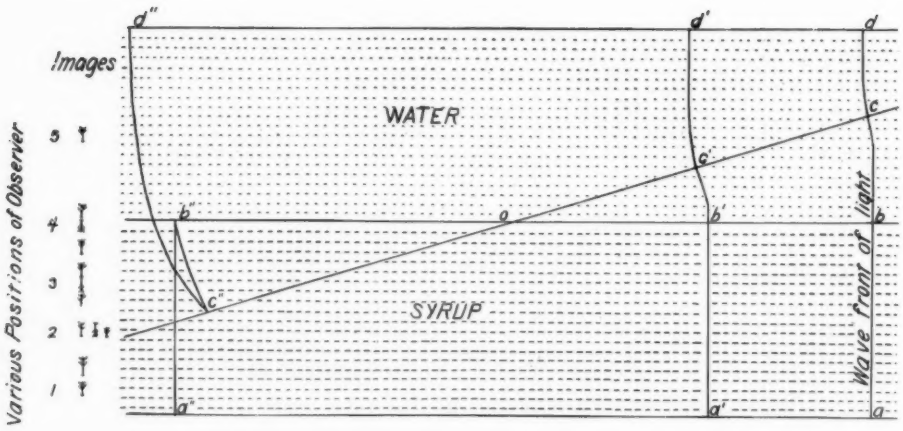
Professor C. S. Hastings [1] of Yale University has recently reproduced the experiment of Wollaston, an English chemist and physicist of a century ago, to explain the phenomenon of mirage. The apparatus consists of a glass tank with parallel sides filled to a certain depth with thin transparent syrup; upon this a layer of clear water is added so as not to disturb the syrup; finally a layer of alcohol is superimposed on the water. These liquids will mix only slowly by diffusion, producing two transition layers, one above and one below respectively. A small palm in the same horizontal plane, represents a "distant object."

If the observer stand eight or ten feet from the tank and view the distant object through it, various images of the palm will appear. At a level where the syrup is unmixed with water as at *1*, [upper figure, page 514], an erect image of the object in its true position and size will

[1] C. S. Hastings, *Light*, pp. 115–126, Chas. Scribner's Sons, New York, 1901. See p. 117 of this volume for method of conducting experiment.

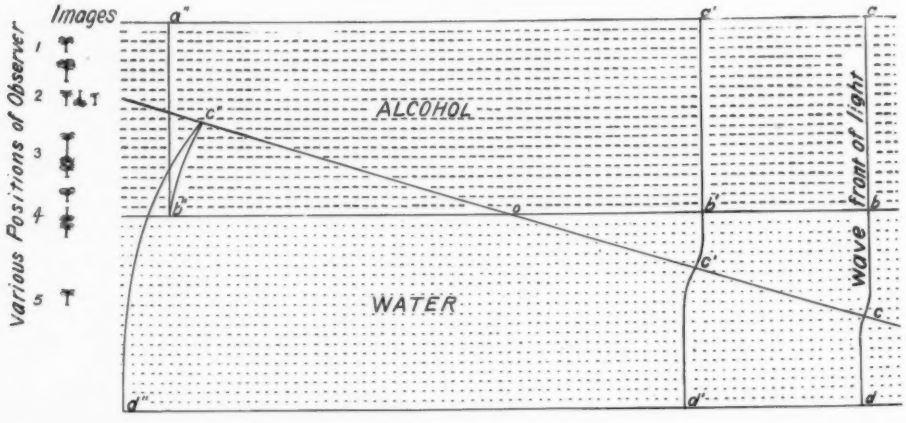


Glass tank with liquids of unequal density, to explain optical effects produced in mirage. See detailed figures following



Lower part of tank experiment: syrup optically more dense than water and separated from it by a mixed transition layer. A single image in normal position can be seen when the distant object is viewed through syrup or water alone, at (1) or (5); but double or triple images, not in normal position, can be seen when the observation is made from a point *below* the mixed transition layer, at (4) to (2). *Drawing modified from Hastings*

be seen. Between *1* and *2* the object is lifted above its true position and increased in vertical dimension. At *2* three images appear, the middle one being inverted. At *3* the inverted image will be about midway between the two upright images. As the eye is raised the inverted image will approach the lower erect one and join it at *4*, which is the transition plane between the syrup and the water. When the eye is at the level where only pure water is in the line of vision, the object is again seen in its true position and magnitude. When the eye is raised through successive positions opposite the alcohol [lower figure], the whole series of phenomena seen through the syrup is reversed, not only as regards position, but also in respect to elongation and compression in the vertical direction. The feature of this experiment which is of striking interest to the



When the observations are made through the upper part of the tank (optically more dense alcohol above less dense water, with a mixed transition layer between), the phenomena are reversed, and mirage effects are seen when the point of observation is *above* the transition layer, between (2) and (4). These laboratory observations illustrate atmospheric mirage, produced by light from distant objects passing through adjoining layers of dense (cool) and rarefied (warm) air. *Drawing modified from Hastings*

observer is the fact that from just below the lower transition stratum and from just above the upper transition layer, double, triple, or multiple images of the distant object can be seen.

In Johns Hopkins University, Professor R. W. Wood has constructed in his physical laboratory an apparatus which reproduces on a small scale certain mirage effects which are very often seen in deserts.[1] This apparatus consists of three slabs of blackboard slate (each a meter long, 20 cms. wide, and 1 cm. thick), mounted on iron tripods and carefully brought into alignment. The surface is sprinkled with sand, to prevent reflection. A mirror mounted so as to reflect the sky when viewed from the opposite end of the desert, is so arranged that the artificial sky comes down to the level of the sanded surface. In front of it is mounted a chain of mountains cut out of pasteboard (with peaks varying from 1 to 2 cms. in height and valleys which come down to the sanded plain). The desert is heated by gas jets. If we look along the sand, the eye an inch or two above the plane of the surface, we shall see, as the desert warms up, what appears to be a brilliant pool of water on the sand and inverted images of the mountains.

When we read accounts of mirages by well-known travelers, we note that the effects produced in the mirages are not always the same. An analysis of some of these accounts will show us the varied physical conditions under which mirages occur and will suggest a possible classification of them.

(1) — Professor Busch, who was the first to make a scientific study and to record data with regard to mirages, saw over a verdant plain eight miles from Bremen, on October 5, 1779, the ordinary image of that town and a second image below, very distinct but upside down.

(2) — When Bonaparte invaded Egypt with his French army in 1798, Monge, one of the learned men attached to that expedition, observed that the delta of the Nile forms a vast horizontal plain, the uniformity of which is broken only by gentle eminences upon which are built the villages. At morning and evening there is no change in the aspect of the country; but when the sun has heated the surface of the plain it seems, at a certain distance off, to be inundated; the villages look like islands in the middle of an immense lake, and below each village is to be seen its inverted image. To complete the illusion, the ground vanishes, and the vault of heaven is reflected in still water. It is easy to understand the cruel disappointment of the French army. Exhausted by fatigue, driven forward by a devouring thirst under the burning sky, these men fancied they had reached a great pool of still water in which they saw reflected the shadow of the villages and the palm trees; but as they gradually approached, the limits of this seeming inundation retreated, and the imaginary lake drew back and finally melted away altogether. The same illusion was repeated in the case of the next village.

(3) — During the French Army expedition of May, 1837, to Algeria, M. Bonnefont, a scientist attached to the expedition, observed a flock of flamingoes about three miles and a half off. As they started to fly, they assumed such enormous dimensions as to give the idea of Arab horsemen defiling one after the other.

[1] R. W. Wood, *Physical Optics*, p. 70, MacMillan Co., New York, 1905.

NOTE.— In the figures on the preceding page the line *abcd* represents a wave front of light after traveling in a horizontal direction a short distance through syrup and water on the one hand and alcohol and water on the other. Syrup and alcohol are optically denser than water, hence the wave front will become bent more and more as it moves forward as indicated by the lines *a'b'c'd'* and *a''b''c''d''*. The concave *bc* portion of the wave front is rendered convex after passing the point *o* and gives rise to an inverted image. The size of the inverted image depends upon the distance of the eye from the region marked *o*, so that if this distance is too small, the vertical magnification will become indefinitely large and the image will not be seen. Thus an inverted image may be seen only when the eye is removed a considerable distance from the tank. In addition to the inverted image two other images are to be seen. Between positions *2* and *4* three portions of the original wave front enter the eye: (1) the straight portion *ab* giving rise to an undeviated and undistorted image; (2) the convex portion of the wave, *cd*, giving rise to a depressed erect image; and (3) the concave portion *bc*, giving rise to an inverted image superimposed upon this and undistorted.

So complete was the illusion that a spahi was sent to reconnoiter. When he had reached a point where the undulations commenced, the horse's legs became so elongated that both steed and rider seemed to be borne up by a fantastic horse several yards high disporting itself in the midst of the water that appeared to submerge it. This illusion persisted until a thick cloud intercepted the sun's rays and the objects assumed their natural shapes.

(4) — Another mirage observed by M. Bonnefont, was effected by a gentle breeze. It became a source of amusement to the French soldiers, when they cast into the air small buoyant objects, such as thistle heads. As these objects drifted farther and farther away, they became larger and larger, and as soon as the wind had made them undulate they suddenly took the shape of small boats, the movement of which, above the apparent waves, was in proportion to the shaking they experienced from the wind. A large number of them presented the curious spectacle of a fleet in disorder. The vessels seemed to dash one against the other, and then, driven by the wind to a great distance, they disappeared as completely as if they had gone down.

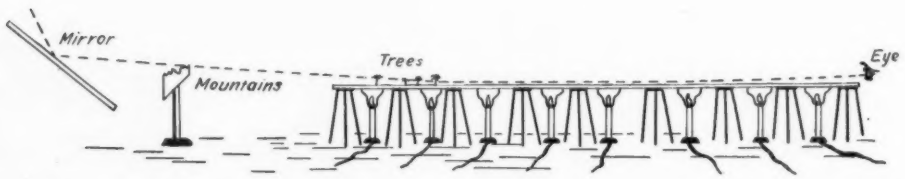
(5) — When A. H. Harrison, author of *In Search of a Polar Continent,* was about five miles from Herschel Island, northern Canada, early in the morning of May 4, 1906, he descried a camp and a number of dogs about two thousand feet above his head. The camp seemed to be pitched on the top of a mountain. It was turned upside down, however, and protruded above a curtain of cloud, which enshrouded the summit, save at the very peak. It appeared no different through a telescope. When he had journeyed a half hour, he came upon an Eskimo camped on the ice — the same apparition which he had beheld inverted and far above him.

(6) — Captain William Scoresby, Jr., the well-known explorer, observed an instance of this kind in the Arctic when he saw his father's ship inverted and very distinct in the sky. With his glass he could distinguish the details of the masts and the hull of the ship which was thirty-four miles distant and fourteen and three-quarters miles beyond the limits of vision.

(7) — At noon, October 15, 1912, on the Antarctic continent, one of Captain Robert F. Scott's parties saw in the sky to the south a wonderful inversion of a pressure ridge. The sun was very hot with no wind blowing.

(8) — On one occasion Woltmann noticed in the air the image of the water, and below suspended upside down, the shores, houses, trees, hills, and windmills. A layer of air separated the inverted images from the objects beneath. On another occasion he observed that the inverted image and the objects beneath were in contact.

(9) — Captain William Scoresby, Jr., ob-



Apparatus designed to illustrate desert mirage. Slabs of blackboard slate mounted on tripods and sprinkled with sand. The mirror reflects the sky when viewed from the opposite end of the artificial desert. Trees, and pasteboard mountains with peaks and valleys, intervene between the light from the sky and the plain. The desert is heated by gas jets, and as the air above it warms up the eye looking along the sand sees in the distance a brilliant pool of water in which the inverted images of the mountains are reflected. ***After Wood***

Tracings from photographs of artificial mirages produced by the apparatus described above. ***After Wood***

served on July 18, 1882, three superimposed images, all inverted and in contact with one another, of a brig and the surrounding ice field.

(10) — Flammarion, the French astronomer, states[1] that for an extent of some six miles the sea upon the Sicilian coast assumed the appearance of a chain of somber mountains, while the waters upon the Calabrian side remained quite unaffected. Above the unaffected waters appeared a row of several thousand pilasters, all of equal elevation, the same distance apart, and of uniform degrees of light and shade. In the twinkling of an eye these pilasters lost half their height and appeared to take the shape of arcades and vaults, like the Roman aqueducts. A long cornice rose upon their summits; then countless castles developed, all exactly alike. These soon faded away, and gave place to towers which in turn disappeared, leaving nothing but a colonnade, then windows, and lastly pine trees, and cypresses, several times repeated.

(11) — Dr. Albert Heim, the Swiss geologist, has described a case observed in the mountains of Thuringia, where he suddenly beheld three lofty peaks appear above an intermediate chain which usually concealed them from sight; and these peaks appeared to be so clearly defined that he was able to distinguish, with an ordinary glass, tufts of grass that were sixteen miles distant M. de Tessan saw a phenomenon of the same kind in the harbor of San Blas, Mexico.

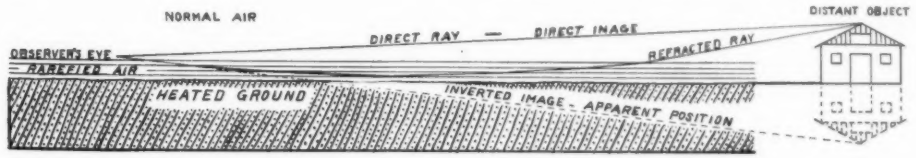
(12) — It is reported that it is an everyday sight to see the Sierra Nevada Mountains on the coast of Spain suspended several degrees above the blue waters of the Mediterranean.

(13) — Another instance is related of a ship that during the Colonial period was expected at New York from England. On a Sunday afternoon, after a violent storm, she was seen floating in the air, every spar represented so clearly that there was no question of the identity of the vessel thus painted in the clouds; but that was the last that was ever seen of the ill-fated ship.

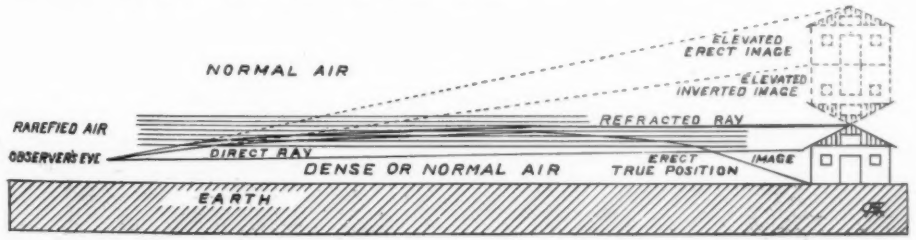
(14) — A letter from Tenerife, published in the *Courier des Sciences* states that from the summit of this mountain, whence the view embraces a horizon of one hundred and fifty miles radius, a mirage rendered visible the Alleghany Mountains in North America, three thousand miles distant.

(15) — It is reported that from Ramsgate, on the southeast coast of England, in fine

[1] Flammarion, *The Atmosphere*, translated by James Glaisher; F. R. S., p. 168, London, 1873. A number of the other observations cited have been taken from this work.



Out of doors when a layer of warm rarefied air arises from contact with heated ground or warm water, occupying a position below the colder, more dense normal air, two images of a distant object may be seen — one inverted beneath the other. [Compare with the upper part of the tank experiment, also see figure on page 520.] This is "inferior mirage" and is explanatory of the appearance of trees and their reflections, which haunts the desert traveler with the hope of water. *Drawing by Chester A. Reeds*



When a zone of warm rarefied air is sandwiched between normal air above and colder or denser air below, a "superior mirage" of distant objects may be seen. Three images are produced, one above the other, the middle one inverted. [Compare with the lower part of the tank experiment, also with page 521 and the figures on page 522.] *Drawing by Chester A. Reeds*

weather, the tops of the four highest towers of Dover Castle may be seen. The remainder of the edifice is concealed by a hill, which is about twelve miles from Ramsgate. On the 6th of August, 1866, at seven in the evening, the four towers were not only to be seen, but also the entire castle from roof to base.

(16) — Upon the shores of the Orinoco, Humboldt and Bonpland observed that the hillocks of San Juan and Ortiz and the Galera Mountains sixteen miles distant, seemed to be suspended in the air; the palm trees appeared to have no hold on the ground. In the midst of the plain of Caracas, these men saw at a distance of a mile and a half a herd of oxen apparently in the air. Humboldt also noticed a herd of wild cattle, part of which seemed to be above the surface of the ground, while the remainder were standing upon the soil.

(17) — Borchgrevink, the first man to land on the Antarctic continent, observed in Victoria Land in 1899 — when he was leader of an expedition to that region — both during the time the sun was low in its descent and when it rose again, a strong mirage effect toward the west, showing images of icebergs far below the horizon, and Antarctic scenery, visible to them only through this phenomenon. This strong mirage remained after the sun's return late in the summer, and the opening of the ice was prophesied thus long before the ice fields near Victoria Land broke up. This Antarctic party watched the northwestern sky with interest, for they could see the far-away broken ice fields with their dark channels and towering bridges, and on several occasions the men became enthusiastic, thinking that they had discovered the masts of the "Southern Cross," their ship, in the mirage.

(18) — From their southernmost point on the Ross Barrier, December, 1902, Captain Scott and his companions saw long snow capes running out beyond Mount Longstaff and meeting the level horizon of the barrier, while farther still the mirage threw up small white patches against a pale sky which were indicative of still more distant capes and mountains. The direction of the extreme land thrown up in this manner was south 17° E., and hence they could say with certainty that the coast line, after passing Mount Longstaff, continues in that direction for at least a degree of latitude, that is, approximately seventy miles. From this they felt sure that the high mountainous coast line does not turn to the east before reaching the 84th parallel. Amundsen, the Norwegian explorer, on his dash to the South Pole, 1911, records that the range did not turn to the east before it crossed the 85th parallel. A mirage thus assisted Scott and his companions, who knew well the appearance of a snow-capped country, in detecting objects beyond their normal range of vision.

When we coördinate these descriptive records and the results of the two experiments previously noted, we find that the interest centers about the number, kind, and association of the images produced by light as it passes from distant objects through or across layers of air (or other media) having different densities.

The upper portion of the tank experiment develops one kind of mirage, the lower portion another. Between position *2* and *4* [lower figure, page 514] the alcohol and water media produce three images in a vertical plane, the middle one being inverted. In the second experiment and in observations (1), (2), (3), and (4), only the inverted and the superimposed erect images appear. The lower image fails to develop.

Optically alcohol is denser than water, hence in the upper part of the tank the optically denser medium is above, the rarer below. To produce similar illusions in the field the same relation of density must exist. This is not the normal condition of the atmosphere, but since there are often temperature variations, it may develop that air layers, in contact with the heated ground or warm water, may be very much heated for a short distance up, producing an unstable condition in the atmosphere. This condition does not extend very far laterally and much less vertically, and consequently in no wise affects the general law of the decrease in density in the atmosphere upward. This variation in den-

sity of the air layers develops most often in the desert or on extensive plains in the summer time. On cold autumn mornings a heated layer may arise over large bodies of water. Slight variations in the supply of the heat may produce grotesque changes in form, as in observation (3), or produce unsteadiness of the image as in observations (3) and (4). In this form of mirage, called "inferior mirage," the inverted object appears to be reflected on a surface of water; in reality it is an inverted image of the sky and of objects which rise above the horizon [graphically represented on pages 517 and 520].

When the images lie in a horizontal instead of a vertical plane, a phase of inferior mirage called "lateral mirage" exists. It is generally developed in the air opposite extensive walls, board fences or high cliffs having a southern exposure.

In the lower portion of the tank experiment the syrup and water media produce between positions *2* and *4* [upper figure, page 514], three images in a vertical plane, with the middle one inverted. The lowest image is the ordinary one, the others have been lifted above their true positions. In observations (5), (6), (7), (8), and (9), a like order of images should occur, the inverted image and the higher erect one appearing as if suspended in the sky. The lower erect one should rest on the surface of the earth. In number (8) the upper erect image is mentioned; in observations (5), (6), (7), and (9), either it was not recorded or it was not seen. Sometimes it may be absent.

In the tank experiment the rarer of the two lower media lies on top and the denser below. To have the same relations in the atmosphere, it is necessary for a zone of rarefied air to be sandwiched in between normal air above and denser air below. Should the rarefied zone reach to great heights, as is suggested in observation (5), no mechanical unstability of the air would arise, since the denser layers are everywhere below the less dense. The illusions will consequently be far steadier and afford much better optical images in this variety, called "superior mirage," than in inferior mirage. Both erect and inverted images of objects, even below the horizon, may be seen in the sky, since in superior mirage the path of the light waves through the rarer medium is concave toward the earth and when the rarefied zone is very high it may be abnormally concave.

A superior mirage may arise where warm air passes over a frozen sea or ice cap and may be local in its distribution. A superior mirage was seen in Paris between the hours of three and four of a December morning in 1869 [see page 521]. The Arctic explorer Scoresby noted that typical examples of this kind were never observed on the sea closer than fifteen miles. Observation (6) illustrates this point [see also figures, pages 517 and 522].

Should the zones of rarefied air in superior mirage be increased to two, three, four or more such zones, a series of images all in a vertical plane would appear. The basal and highest ones would be erect images, and the intermediate, inverted ones. Such an effect is called "multiple mirage." Observation (9) is a record of one. Mr. Albert Operti, the artist with Peary in 1906, sketched a multiple mirage which he saw. It consists of four inverted images between two erect images, of a distant island and the surrounding ice floes [page 512]. The objects which gave rise to the mirage were not seen at first, but as the ship drew nearer to them, they were sketched in position.

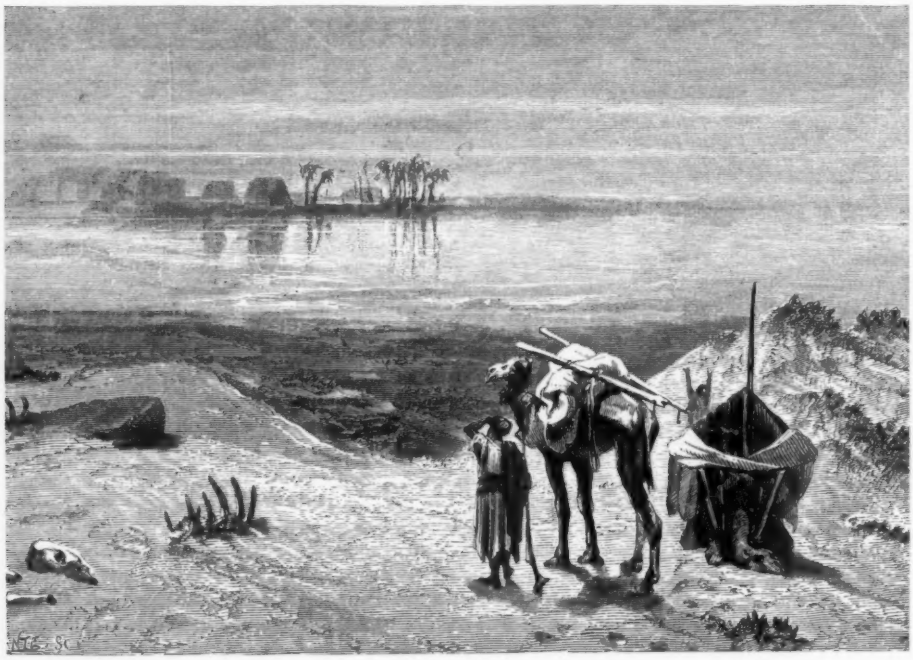
When the images produced by inferior,

lateral, superior, or multiple mirage are abnormally elongated vertically, or appear deformed, broken, and repeated, such as described in observation (10), a variety of mirage called "Fata Morgana" is said to exist [page 523]. The light rays instead of being bent in plane and regular strata of air, as in the other types of mirage, are refracted in curved and irregular strata. Magnification of objects may occur in all directions, but chiefly vertical — parallel with the axes of cylindrical air fields. If these fields should be broken or repeated several times and remain far distant from one another, the images produced will have a similar distribution.

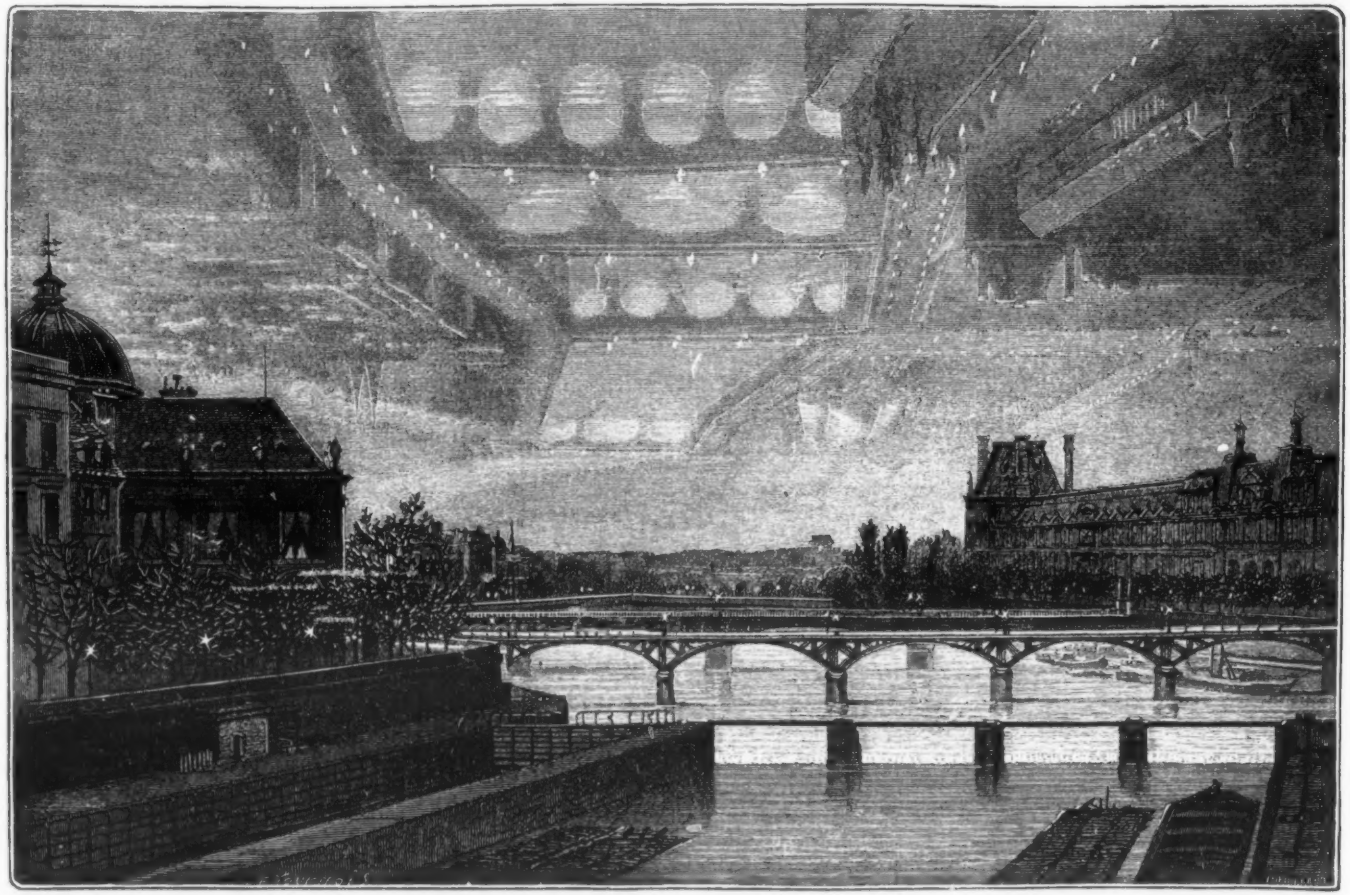
This form of mirage is often observed on the seashore at Naples, Reggio, and on the Sicilian coast. The Italians have named it "Fata Morgana" after the fairy Morgana, of Arthurian romance. The phenomenon generally occurs in the morning in very calm weather.

Fata Morgana is of frequent occurrence in the polar regions in the vicinity of distant floating ice rafts. Slight irregularities on the ice floes appear as lofty pinnacles. Open lanes between the ice floes sometimes appear as dark vertical lines. Scott, Mawson, and members of the Scottish National Antarctic Expedition have noted this form of mirage appearing on the ice field of the great Antarctic continent where crevasses or cracks appear in the ice. Warm air rising from these cracks into cold air varying in temperature from 22° F. above zero to 20° below, raises points of ice only a foot or two in height into battlements with castellated towers.

When the sea is apparently concave

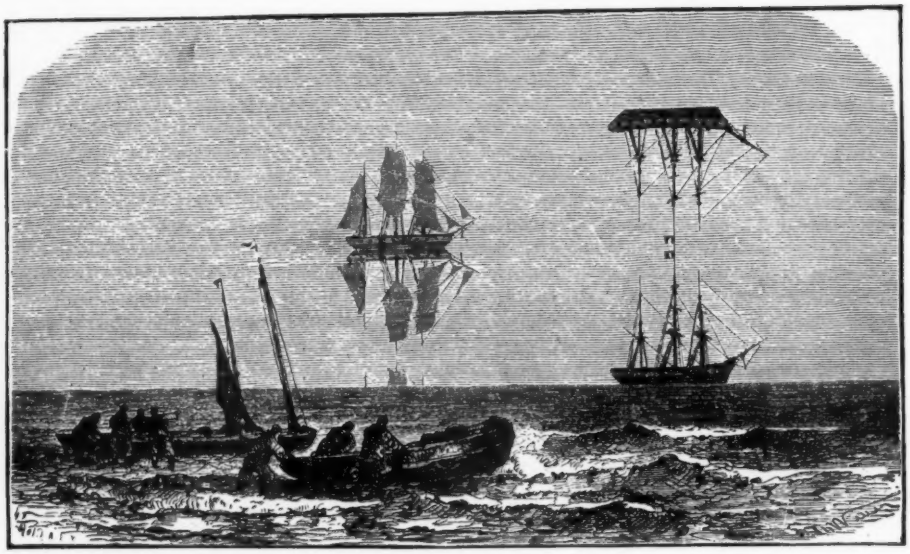


The illusory appearance of a brilliant pool of water reflecting trees and other objects, is well known to travelers in the desert. It is due to the layer of warm rarefied air above the surface of the hot sand, which refracts rays of light from objects beyond it and makes inverted images of them appear to the observer. The sky near the horizon is refracted in the same manner, producing the deceptive lake. *From Lockyer*



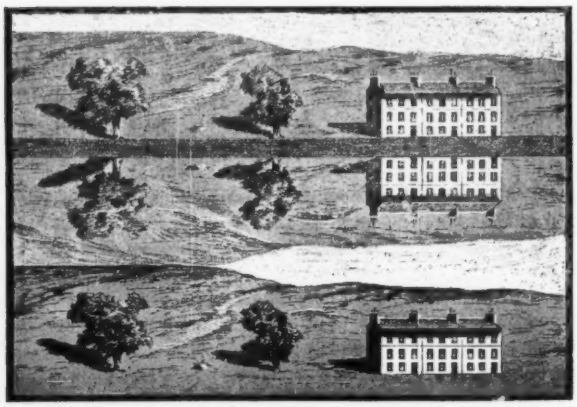
SKETCH OF A SUPERIOR MIRAGE SEEN IN PARIS IN 1869

This appearance was seen between the hours of three and four on a December morning and was due to the presence of a layer of warm air sandwiched between a layer of cool air in contact with the earth and normal air above. The normal image of the objects is seen below and an inverted one above. *After Flammarion*

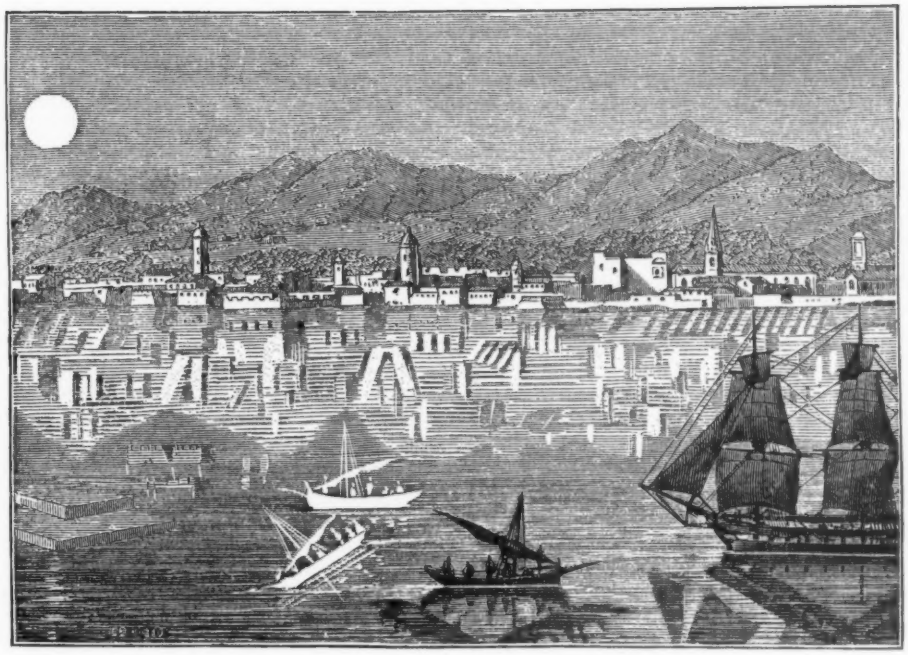


Ships with their inverted images in the sky are sometimes seen at sea (superior mirage). The one described by Captain Scoresby, Jr. in 1822, in Greenland waters, was an image of a ship then thirty-four miles distant and fourteen miles below the horizon. The upper image which theoretically should appear is sometimes not noticed or is absent. *After Herman, Klein, and Thome*

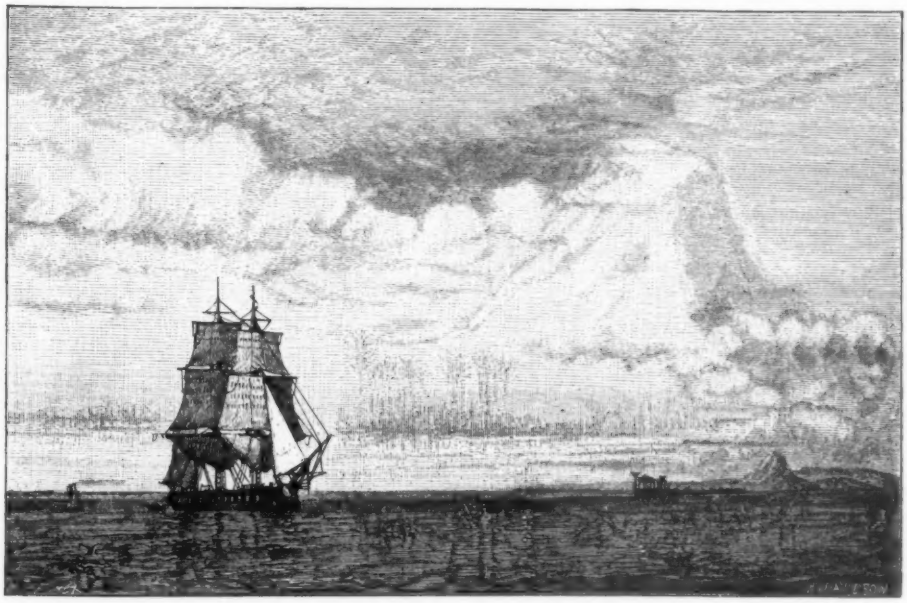
and the horizon is seen above the hulls of ships, or when distant shores take the form of high cliffs and very distant objects seem to rise into the air like clouds, the variety of mirage known as "looming" is said to exist. Owing to the absence of the inverted image in looming this variety may not at first appear to be as striking as the other forms of mirage, but when objects far below the sensible horizon are lifted up in the sky as mentioned in observations (11) to (18) it arouses especial interest, particularly from explorers. It assisted Scott and his companions, who knew well the appearance of their snow-covered Antarctic country, to detect objects beyond the normal range of vision. If observation (14) from Tenerife be true, it is one of the most striking observations ever made of looming. In this instance the ratio of the distance from the observer to that beyond it, is one to twenty; the trajectories of the light rays must have reached tremendous heights, otherwise the observer would not have seen the Alleghany Mountains of North America lifted up in the sky. When looming is produced on a smaller scale the rays of light which give rise to the upper erect image in superior mirage [page 517] may lift mountains, trees,



Superior mirage on land, similar in principle to the above. *Flammarion*



The type of mirage called by the Italians "Fata Morgana" (from the fairy Morgana of Arthurian romance), occurs when the images produced by the various types of mirage are abnormally elongated, deformed or broken, due to the curving and irregularity of the layers of air. The one shown above was seen on the Italian coast, where such mirages are common, as they are also in polar regions. *After Flammarion*



The kind of mirage known as "looming" is one of the most interesting. There is no inverted image, but low shores may be reflected in the sky as high cliffs, and mountains and objects far below the horizon may appear lifted up in the sky and magnified. Scott and his party made use of this phenomenon in the Antarctic to detect objects beyond the normal reach of vision. The picture shows a landscape with palm trees and mountain as seen when lifted up and magnified by looming. This is the kind of mirage which may have given rise to Peary's "Crocker Land." *After Appleton's Journal*

or other objects up into the sky and magnify them [see page 523].

In June, 1906, Peary saw[1], approximately 120 miles to the northwest of Cape Colgate, and later from Cape Columbia, "the faint white summits of a distant land above the ice horizon" which he called "Crocker Land." This is somewhat like Scott's observations of looming in the Antarctic in 1902, observation (18), which were confirmed by Amundsen on his dash to the South Pole and back.

Mr. MacMillan and Ensign Fitzhugh Green covered 152 miles of the intervening floe ice in the spring of 1915, in search of "Crocker Land," before circumstances compelled them to turn back. Twice while en route and once after they returned to Cape Thomas Hubbard, they saw what proved to be a mirage extending through at least 120 degrees of the horizon. MacMillan describes the mirage[2] as follows:

"April 21st was a beautiful day; all mist was gone, the clear blue of the sky extending down to the very horizon.... Great heavens, what a land! Hills, valleys, snow-capped peaks extending through at least 120 degrees of the horizon!....As we proceeded, it gradually changed its appearance and varied in extent with the swinging around of the sun, finally at night disappearing altogether.

"The 27th, on which day we marched from igloo No. 5 to No. 3, offered the same perfect weather and perfect going, all leads being frozen. Throughout the day the mirage of the sea ice resembling in every particular an immense land, seemed to be mocking us. It seemed so near and so easily attainable, if we would only turn back."

Later at Peary's cairn, Cape Thomas Hubbard, he writes: "The day was exceptionally clear, not a cloud or a trace of mist; if land could ever be seen, it could be now. Yes, there it was! It could be seen even without a glass, extending from southwest true to north-northeast. Our powerful glasses, however, brought out more clearly the dark background in contrast with the white, the whole resembling hills, valleys, and snow-capped peaks to such a degree that, had we not been out there for one hundred and fifty miles, we would have staked our lives upon it. Our judgment then as now is that this was a mirage or loom of the sea ice."

If Peary's observations had been extended over a longer period no doubt he would have observed that his "Crocker Land" was an instance of looming. MacMillan's description is not fully specific, but it seems to have been a clear case of looming. The numerous pressure ridges which were frequently met with, could well, under abnormal atmospheric conditions, give rise to "the immense land with hills, valleys, and snow-capped peaks."

[1] R. E. Peary, *Nearest the Pole*, p. 202. Doubleday, Page & Co., New York, 1907.

[2] D. B. MacMillan, In Search of a New Land. *Harper's Magazine*, November, 1915.

Insects may take twenty per cent of the fruit crops in the United States, but in return they give us the remaining eighty per cent, for they pollenate the flowers and so enable the fruit to develop. Photograph from wax model of apple blossoms exhibited in the insect hall of the American Museum

Insects

AN INEXHAUSTIBLE AND RELATIVELY UNTOUCHED FIELD FOR RECREATION OR RESEARCH

By FRANK E. LUTZ

THERE are certain threadbare subjects which contain so much poorly appreciated truth that additional articles upon them may not only be pardoned but also welcomed. One of these is certainly the importance of insects. Important? In all ways. They are small but mighty and I almost believe that, even as to bulk, they would run other groups a close race. If all the insects were one insect what a great insect that would be!

When we consider the number of species, there is really no good second to insects. There are as many (probably more) kinds of these animals within a hundred miles of New York City (even though that circle contains a great deal of insectless salt water) as there are of birds in the whole world. The figures in the note below[1] are not accurate — they cannot be made so — but they are intended to be fair. Even if there were no other considerations, would not the fact that approximately three-quarters of the known species of animals of the world are insects, place them in the top rank?

Think of the chance for studies of life histories — more than ten thousand

[1] The following shows the number of described species in the various animal groups, with insects not only leading in number of species but also standing for approximately three-quarters of the whole number of known animals of the world:

Insects	400,000	Worms	7,000
Mollusks	50,000	Arachnida	5,000
Fishes	15,000	Protozoa	5,000
Birds	13,000	Reptiles and Amphibians	5,000
Crustaceans	8,000	Mammals	4,500

different ones within a few hours' travel of your home. Some of these are in water, others underground; some in or on plants, others in or on animals; some only in the midst of the near swamp or on the top of the hill over yonder; others in your garden or even in your house. Insects keep "cows," building sheds to cover them, make gardens, have slaves, construct houses for themselves and offspring, dig caves, hollow out wood, sing songs, catch prey and have all sorts of devices to keep from being caught, go to live with their relatives, and make themselves generally interesting. What a wealth of material and how neglected!

An earnest amateur can learn in a week to recognize all the reptiles and amphibians of his neighborhood. It is indeed a poor nature lover who can not give at least some name for every commonly seen mammal within hundreds of miles around him. Singly and by crowds we get up and bedraggle ourselves with dew to hear or see a few different kinds of birds, and we mark that day in red which has permitted us to find a bird's nest with a few smooth, splotched eggs in it. And we do well to do it, but ——. Can you give names to a tenth of the insects you see every year, beyond calling most of them "bugs" when really very few of them are bugs, or saying that it is a "buffalo moth" when really it is a beetle, or a black "beetle" when really it is a roach? What is that creature on your rosebush singing in a subdued treble? "Now that you mention it, I do hear something but I have n't the faintest notion what it is." Eggs? No bird's egg ever laid can surpass in delicacy of coloring hundreds of different kinds of insect eggs; and there are the multitudinous shapes and intricate carvings — not merely smooth ovoids. I have probably not examined one per cent of the insect eggs which are laid every year in my garden. Have you in yours? There are a-plenty there at the moment you read this. Some are on the branches, others are under bark, others are placed in neat slits made in stems or leaves by the mother, others are underground. The garden is full of them now and full of insects too.

Of course it is winter but the red and black butterfly which lately emerged from "a pale green house studded with golden nails" is the only one of our insects which is definitely known to leave us when winter comes. They are here as eggs, as larvæ, as pupæ, and as adults. Most of them are hard to find but that is the fun of it, the training in it, the dare which the insect world holds out almost unchallenged.

About the time this is published the largest gathering of scientists ever held in the United States will be meeting in this city. What can the chemists tell us about the firefly's cold light, or the gall maker's sting which causes plants to produce growths different from anything which plants would ever produce by themselves — often beautiful and usually so definite that the maker can more easily be identified by its work than by its own looks? What can the physicist tell us of insect flight (the curving of a beetle's elytron, the monoplane of the house fly) or of the sounding board in a male cricket's wing? Psychologists have written galore of instincts and insect activities but the campuses of their colleges are full of untouched material. Sharks are dissected for anatomical studies, the development of starfish eggs is most minutely observed in order to understand embryology, and hundreds of dollars are spent in raising rats, mice, guinea pigs and the like, for the purpose of discovering the laws of inheritance. Strength to such work, but ——. Insects have anatomies

too, curious anatomies, adaptations to all sorts of conditions, vestiges of ancient structures and the very newest wrinkles in many lines. Insects have embryos too; apparently almost anything may happen between the time the sperm enters the egg and the time when new eggs are formed, or there may be no sperm — not even a male. Sometimes this happens regularly every other generation, sometimes the Amazonian state lasts for an indefinite number of generations and then males appear. Why? Other groups of animals show a similar condition of affairs but they are not in my yard, or in yours, and we must have a compound microscope to see them. When it comes to the study of inheritance I venture to say that one certain species of insect has taught us more about the intricate laws governing the transmission of characters, the relation between these and the chromosomes in the germ cells, about sex itself, than all the backboned animals put together. Each individual of that species took from the meager budget of the biological department merely a minute bit of rotten banana for food and a milk or olive bottle was a luxurious cage for hundreds of them.

But let us come down to earth and see how our pocketbooks and, indeed, our very lives are affected by insects. Even I hesitate about mentioning the relation between the yellow fever mosquito and the Panama Canal; but have you or any of your family ever had malaria? An insect did it. Did your baby have "summer complaint" last season? Very likely a fly fell into the milk or walked over the butter. The fly's feet were not clean but he could n't help it. Neither can the mosquito help giving you malaria, nor our neighbors to the south, yellow fever. Probably the parasites they carry, and incidentally pass on when they come for a meal, worry them too. We have all heard about the tsetse flies and the keeping of horses and cattle out of certain parts of Africa. Apparently tsetse flies have been at this trick for some time as there were Glossinæ in Colorado during Miocene times and Henry Fairfield Osborn believes they may account for the disappearance of certain mammals from North America.

It has been said that old maids are the support of the British Empire for they keep cats; cats destroy field mice which prey upon bumblebee's nests; bumblebees insure seeds to red clover; red clover makes good beef; and good beef makes big strong men who extend and keep up the British Empire. It is typical of human arrogance and egotism that the beginning and end of that amazing chain of logic should be *Homo*. *Bombus* is far more important. She went bustling about fertilizing clover and other plants before there was a British Empire, or old maids either. Mice may have broken into her nest but she did not need the pampered nuisance of Egyptian heathenism to take care of that. We stretch out our hands, sigh, and mournfully quote "Full many a flower is born to blush unseen and waste its sweetness on the desert air." Unseen? Waste? Do you really think the petals were painted or the perfume distilled for the sake of an animal who, if he does not pass them by unseen or unsmelt, is apt to break off the flower and shortly throw aside its withered beauty, or else to breed and breed the plant until he has succeeded in making it different, an "improvement" upon the work of its Creator? Those petals and those perfumes were developed quite independently of man and for the attraction of what he sometimes disdainfully calls "bugs."

I do not know how the figures stand now but not so very long ago there were, in the United States, fourteen times as many deaths due to malaria and intestinal diseases (many of which are carried by insects) as were caused by railroad accidents. Insects caused a property loss in the United States of five times that caused by fire. They took twenty per cent of the fruit crops in the United States, but in return gave us the remaining eighty per cent, for they pollenated the blossoms and so enabled the fruit to develop. In fact, the damage done by insects is due almost entirely to less than one per cent of the species, and a large number of the remainder spend their lives keeping these in check. Human efforts have failed to exterminate the gypsy moth, and the United States government is now importing insect parasites of the pest to aid in the work. The Australian lady beetle has saved the orange groves of California from the white scale.

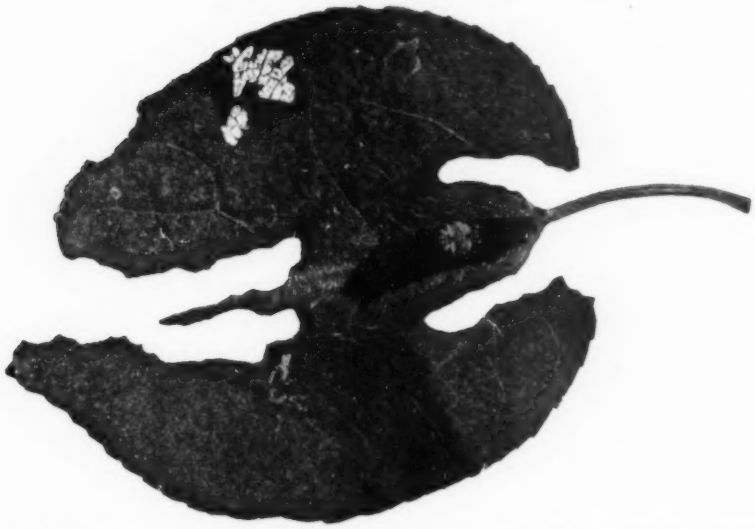
While these considerations — and page upon page of unexaggerated statistics could be given to enforce the point — are important, Thoreau was not far wrong when he said: "We accuse savages of worshiping only the bad spirit or devil. Though they may distinguish both a good and a bad, they regard only the one which they fear, worship the devil only. We too are savages in this, doing precisely the same thing. This occurred to me yesterday as I sat in the woods admiring the beauty of the blue butterfly. We are not chiefly interested in birds and insects, for example, as they are ornamental to the earth and cheering to man, but we spare the lives of the former only on condition that they eat more grubs than they do cherries, and the only account of the insects which the state encourages is of the insects injurious to vegetation."

Far be it from an entomologist to apply Thoreau's characterization to the governing bodies of our educational institutions. When universities fail to provide, in a curriculum, more than a smatter for the study of insects, they are merely reflecting the general state of human minds. It is more difficult, on the average, to identify an insect than an animal belonging to a smaller group, yet if museums provided curators of entomology, with the same liberality with which they provide curators of vertebrate animals, there would be in the American Museum alone, in proportion to the number of species involved, more than seventy-five on the scientific staff working with insects, carrying on research, identifying specimens for amateurs, writing leaflets to interest and help the layman, as well as supervising the preparation of exhibits which would not only display the interest and wonder of insect life but also explain, by their efficient aid, the problems of general biology.

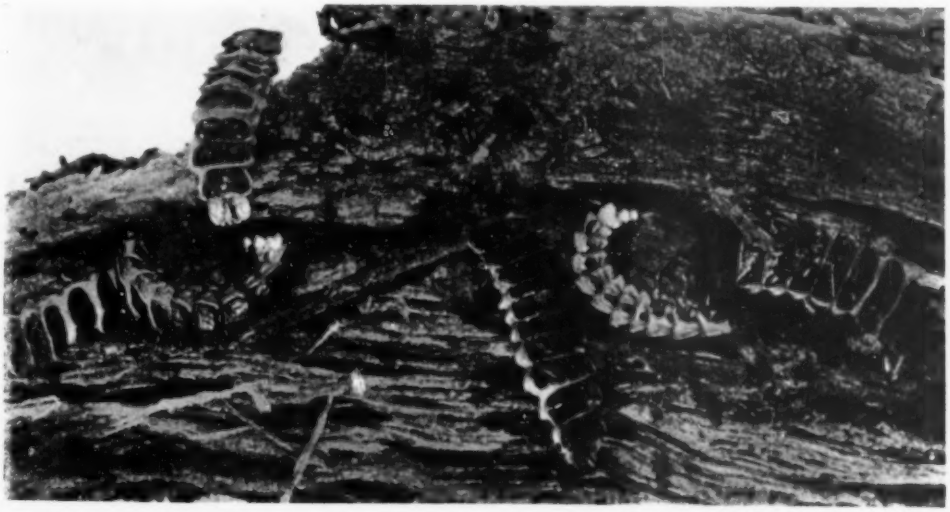
Why are things so? I do not know. When people really get acquainted with even a few insects there is no lack of interest. Twice a month about a score of business men, lawyers, doctors, stockbrokers and "laboring men," meet in a room in this Museum and discuss insects with an enthusiasm not surpassed by any society affiliated with the New York Academy of Sciences. A similar society meets in Brooklyn; another in Newark. These men, each from his own viewpoint, appreciate insects. Perhaps the reason most of us do not, is because we still cling to the ideas of centuries ago when everyone understood "Beelzebub" to mean literally "lord of flies."

SOME STRUCTURES AND INSTINCTS OF COMMON INSECTS

PHOTOGRAPHS BY MARY CYNTHIA DICKERSON



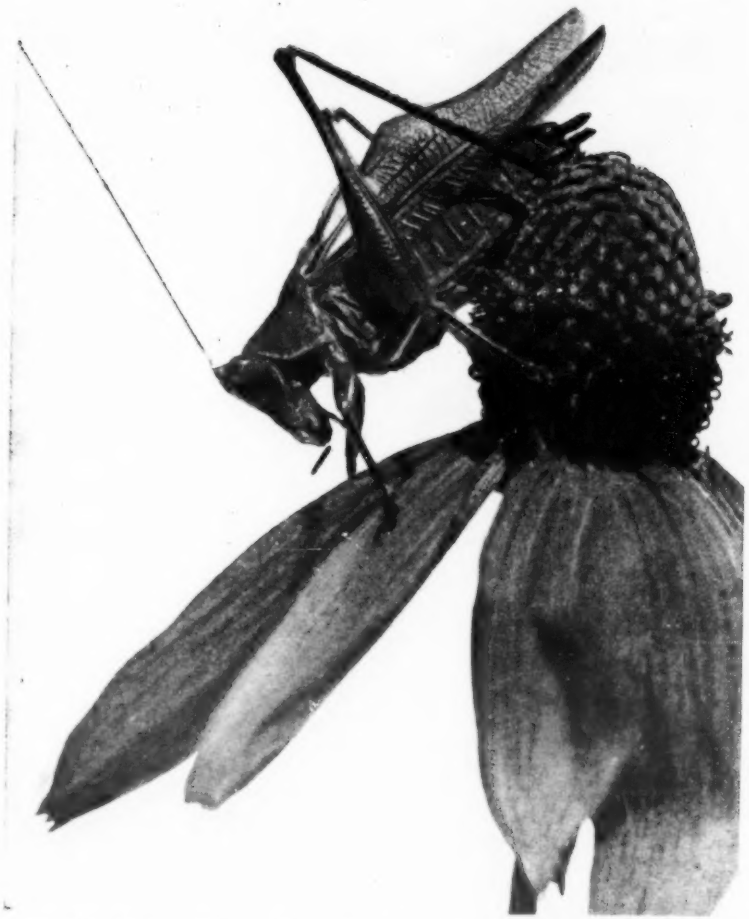
Approaching winter catches the second brood of the viceroy butterfly in the early caterpillar stage and the small atom of life must protect itself as best it may. It sets about to build a house by a rather elaborate process: it cuts a leaf, as above, and continues until both sides fall away; then with threads of silk it draws one side of the remnant of the leaf over to the other side, above its head. It fastens the stem securely to the twig, and lines the house with many layers of silk. Then it crawls in headfirst, and hibernates nearly six months, swept by boisterous winds in a temperature often below the zero point



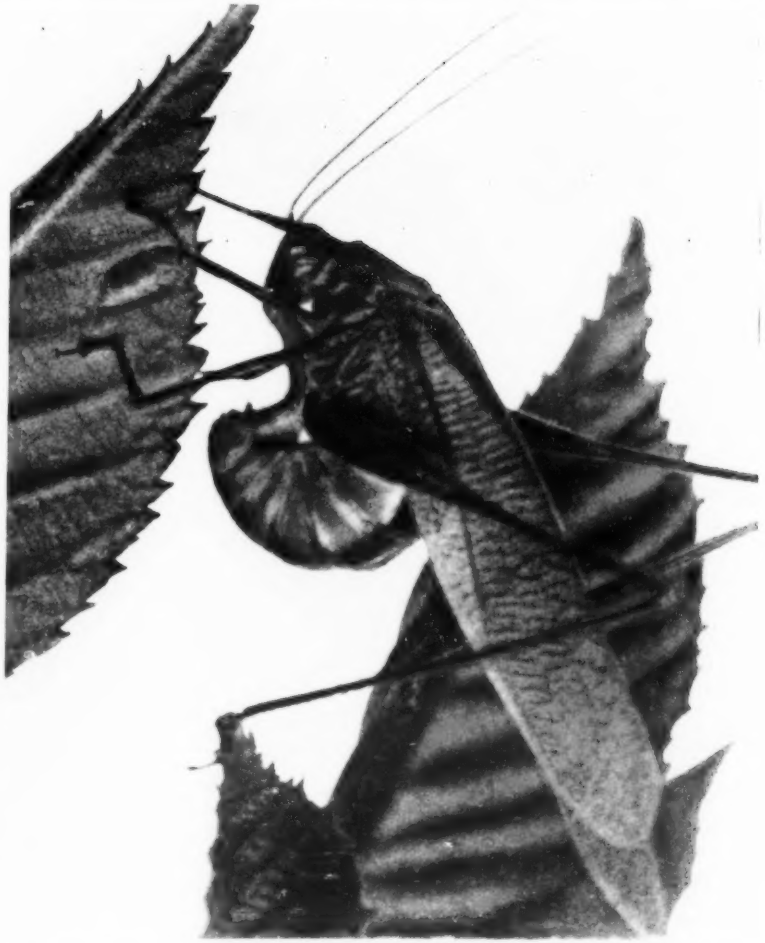
Break open a decaying chestnut stump in the frozen winter woods and in its frost-lined chambers we may find dozens of hibernating glowworms, each bearing its cold light. Who can explain this hibernation, when even breathing is suspended? Who can explain the glowworm's light? Who the instinct that teaches insects to crowd together in winter quarters, when the woods present hundreds of places apparently equally good? Insects may be frozen "stiff" so that they break at a touch like fragile glass, yet return to their full vitality at once on a renewal of high temperature. Each glowworm of the species shown above changes into a white and pink chrysalis in May, which after a week sheds the skin and becomes a firefly, a black beetle ornamented with red and yellow on the thorax

Courtesy of Ginn and Company and Doubleday, Page and Company

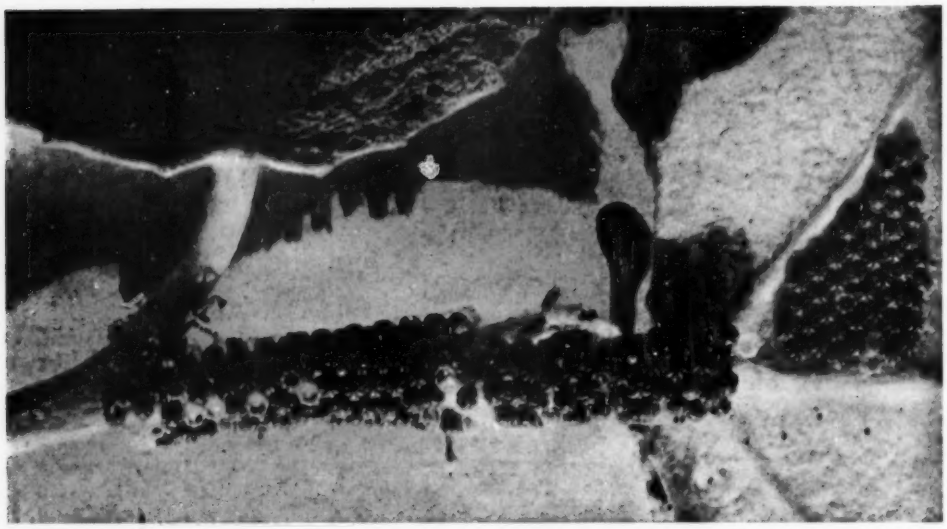
This caterpillar of the monarch butterfly—hanging head downward—is ready for the metamorphosis. It hatched from a minute egg in late summer and has grown for two weeks. It stopped eating and wandered restlessly about and has now chosen a secure spot on which it has spun a small thick carpet of silk. It walked over this until the hind feet with their many minute hooks were entangled in the silk, then, letting go its hold with the other pairs of feet, it hung head downward, motionless. The skin now loosens, and after twenty-four hours splits over the head. At this stage the caterpillar becomes very active: by muscular contraction it works the skin off upward into a small shriveled mass; then during the few seconds longer that it still remains attached to the skin, it reaches out its slender end (which also is supplied with hooks) and with great effort and force pushes it up into the silk carpet. The whole process has taken but three or four minutes by the watch. The creature now rests. Slowly the shape changes, the segments above contracting, the form rounding out; and behold an emerald-green chrysalis studded with golden spots! In this form the insect is wholly immovable—although wonderful changes are taking place within, absorption of structures useful to the caterpillar and perfecting of others necessary for the new life of the butterfly. In two weeks the pattern of the butterfly's brown and orange wings begins to show through, finally the chrysalis skin, in its turn, splits over the head, and the butterfly crawls out. Such is one of the simplest and best-known stories of insect metamorphosis



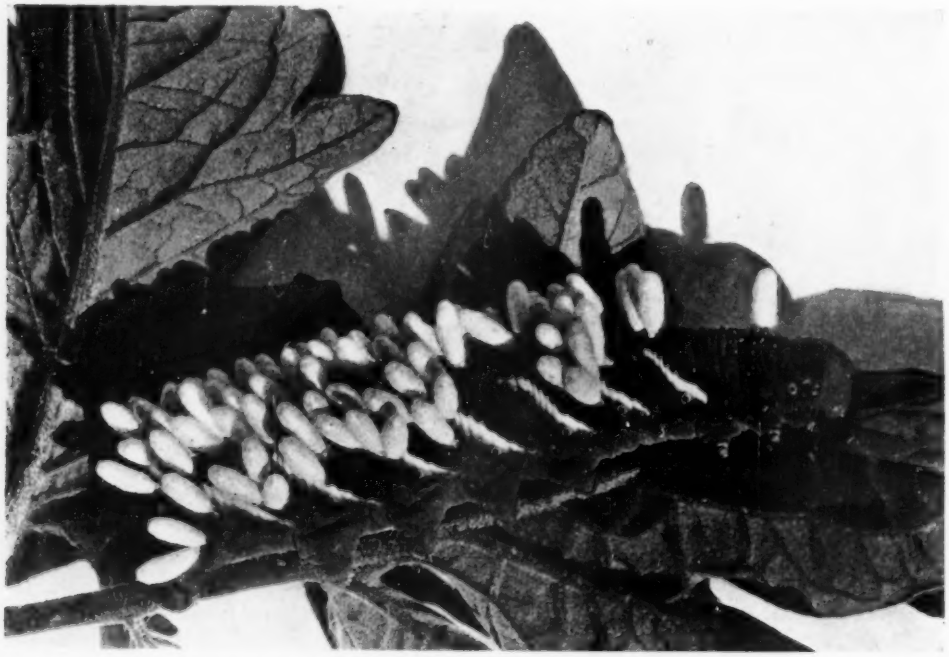
The "singing" meadow grasshopper [x 2¼] on a coneflower by the roadside in September. He is an instrumentalist and rasps his one theme over and over, "Zr-r-r-r-r-r-r! jip! - jip! - jip! - jip!" The bases of his wings are like overlapping plates of isinglass and while singing (he always prefers to sing head down) the wings rasp over each other at these bases and beyond spread apart to form a trumpet-shaped resonating chamber. The wings vibrate conspicuously at first, but as the music proceeds the movement becomes too rapid to be visible to the human eye. The meadow grasshopper takes so much delight in his own singing (?) (his ears are on his front legs), that he rasps away all day in the sunshine and then again all night—except in somewhat slower time corresponding to the lowered temperature



The female narrow-wing katydid [enlarged] has just deposited an egg in the raspberry leaf. She curved her body underneath her, put the thin sharp end of the ovipositor against the edge of the leaf, and with considerable effort pushed this tip and then the whole scimitar-like organ into the leaf. After a pause she slowly withdrew it, leaving an egg snugly hidden within the leaf between the upper and lower epidermal layers. This is in September. The leaf falls to the ground and dies. The egg lives, and by the middle of next June there will hatch from it a ludicrously diminutive (⅛ inch long), transparent, and large-headed baby katydid. Can we tell where even a few of the commoner insects lay their eggs? Or explain the wonder that so minute and helpless a fragment of life as an insect egg can survive the perils of winter?



Delicately patterned yellow eggs [x 3½] of a mourning cloak butterfly. The little caterpillars come out at the tops of the eggs after about two weeks. No bird's egg ever laid can surpass in delicacy of coloring hundreds of different kinds of insect eggs, and they are of multitudinous shapes and intricate carvings. Every garden is full of them at this moment, although it is winter



The caterpillar of a tomato sphinx moth—a famous case of parasitism, where the caterpillar not only is destroyed by the parasites but also must carry the cocoons of its destroyers about on its back. If it escapes attack until it is full grown, it becomes possessed by a strange instinct which makes it desert the high leaves where it has been feeding in the sunshine, descend to the ground, and plow headfirst down into the darkness—to sleep until ready to transform into the winged moth. There are plants incapable of making seeds unless these sphinx moths bring them pollen. There are injurious insects which man keeps in check by means of their parasites

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THE DE VINNE PRESS, NEW YORK

Photo by Philip S. Farnham

Does are now safe from the hunter, although at one time they and the fawns were the chief victims in the shooting season. Under the "buck law," the deer in Vermont, which were almost exterminated forty years ago, have increased until six thousand bucks were killed there last open season

Common-Sense Law in Game Protection

By JOHN B. BURNHAM

President of the American Game Protective Association

LAWS which govern us have been aptly defined as "rules of action." Game laws in this country are rules designed to prevent the extermination of our wild species. Both sentimental and selfish reasons are behind our game laws. It is a religion with some men to exert themselves to protect the wild game solely that posterity may benefit thereby. With others, the incentive is to perpetuate a sport in which they are interested.

Both sentiment and selfish interest meet on the ground of common sense. There can be no division of opinion when it is shown that a species has been killed off more rapidly than it breeds. The only important difference of opinion likely to occur among game protectionists is as to when and to what extent any particular species requires protection.

In this country in recent years some very interesting problems in game protection have developed in which the old method of simply shortening the shooting season is either not sufficient or not practical as a means of conserving the supply, and where neither the reduction of the bag limit nor the prohibition of the sale of game will avail. Here for the first time on a large scale the park principle

of preserving the female animals and birds and only permitting bucks and cocks to be killed has been put in practice. The results already obtained show conclusively that this is one of the most valuable methods of preserving game which has ever been tried, and while the plan received its initial support from men who were actuated by unselfish motives, it has proved so practical that it has now won over most of the other element as well. The remarkable result obtained by state protection of hen pheasants in New York and of doe deer in Vermont will serve to illustrate what may be accomplished under such a system.

Only deer with horns longer than a fixed minimum size are allowed to be killed, so that the hunter, before shooting, must first be very certain of the nature of his quarry. Thus the buck law has the advantage of protecting human life

Ten years ago game of all kinds, with the possible exception of cottontail rabbits, was extremely scarce in Monroe County, New York. As far as the writer has been able to ascertain there were no quail left in the county and but few ruffed grouse. Many local sportsmen had either abandoned shooting or else chosen other localities. Today, however, the situation is reversed and men from distant portions of the state and even from other states are attracted to Monroe County for field shooting. The cause of this improvement has been the introduction of the Chinese ringnecked pheasant, coupled with the protection of the hen birds.

For six years prior to 1904, the State Forest, Fish and Game Commission sent to applicants in Monroe County one hundred and thirty-five pheasants which were distributed in various localities for stocking purposes. In 1908 the pheasants had increased to such an extent that a very short open season was given for cock birds only. A year later a careful estimate indicated that more than six thousand pheasants had been killed in the county and from that time until the present the supply has been increasing despite the fact that on each shooting day Rochester alone sends thousands of sportsmen over the county by the various trolley lines radiating from that city. If it were possible to protect female grouse, similar results, although in less degree, might be hoped for. Unfortunately however it is impossible to distinguish the sexes of grouse at shooting distances and therefore this method

can never restore our noblest game bird.

In this country, deer hunting has been subjected probably to more abuses than any other field sport, until the term has become almost synonymous with cruelty and butchery. Any one reading Charles Dudley Warner's story of deer hounding, who has not been moved to pity, must be cold-hearted indeed. Under former conditions does and fawns were the chief victims of the open season. Sportsmen had caused their extinction. In 1878 seventeen deer procured from the Adirondack section of New York were released in Rutland and Bennington counties. Thereafter these deer were protected by an absolute close season for nineteen years. In 1897 an open season was given which has been continued each year since that time. During the nineteen seasons which have since elapsed bucks only have been killed, with the exception of three recent

Photo by G. A. Bailey, Geneseo, N. Y.

Pheasants feeding at winter feeding station of the Geneseo County Bird Club. As long as the snow was on the ground they came regularly to be fed, but afterward made no use of the food put out, seeming to like weed seeds and wild fruits better than the corn, buckwheat, and kaffir corn. These birds have been protected for two years and are increasing in numbers

endowed with sentiment therefore hailed with enthusiasm the advent of a law which protected these helpless creatures. From the practical standpoint Vermont furnishes the best illustration of the common-sense value of such a law.

Forty years ago deer were practically exterminated in the state of Vermont. There were a very few left in the wilder portion of northeastern Vermont adjoining New Hampshire but throughout the rest of the state merciless hunting years when an open season for does also was given on the ground that deer had become too numerous and were destroying orchards and otherwise damaging farm crops.

Last fall six thousand deer were killed in Vermont. The average during the first four years of the open season, from 1897 to 1900 inclusive, was only one hundred and fifteen deer a year. The remarkable fact is that this great increase in Vermont deer has not taken

place under the protection afforded by a close season but under the "buck law." In proportion to its hunting area more deer are killed under a buck law in Vermont at the present time than in any other state under any kind of law. The deer are also the heaviest and finest specimens of the Virginia deer to be found in the United States. The future of the species is thus assured for all time.

The theoretical increase of deer under a law protecting does and fawns has been very interestingly presented in a table prepared by Dr. A. K. Fisher and Prof. F. E. L. Beale, of the United States Biological Survey, from suggestions made by George Shiras, 3d. For purposes of the comparison it was assumed that a breeding stock of twenty-four bucks and twenty-four does, aged two years, was available, and that the increase annually thereafter was one and one-half fawns a pair. The ratio would not, of course, be affected if fewer or more were taken as the original stock or as the increase. Under a law permitting indiscriminate killing, and assuming that fifty per cent of the deer were shot annually, extermination would result at the end of ten years during which period one hundred and fifty-five deer would have been killed.

Under exactly the same conditions, with the single exception of limiting the killing to bucks more than one year old, at the end of the ten-year period 781 would have been bagged and there would remain a breeding herd of 781 bucks and 1562 does, or a total of 2343 live deer in the woods. Thus is demonstrated that with a buck law good shooting is afforded and the supply of deer is simultaneously increased.

It seems incredible, in view of these facts, that any sensible persons still desire a law permitting the killing of does and fawns; and yet there is an even more important reason than the economic one for the buck law: that is the saving of human lives.

The buck law, as commonly found on the statute books, prohibits the killing of all deer, except deer having horns in excess of a certain minimum length, three or four inches usually. This provision requires the hunter to exercise caution before shooting. If he waits long enough to ascertain that a deer has horns of legal length he is not likely to shoot anything else by mistake. Incredible as it may seem, there are hundreds of men in this country who, under a law permitting the killing of any kind of deer, will shoot at almost anything that moves in the woods. The writer of this article, who is an ardent deer hunter, has twice narrowly escaped death by reason of criminal carelessness of this character. Instances are common under the old form of law, of shots being fired at dead deer which were being carried on men's backs or were being hung up, and of horses and cattle killed, as well as of men losing their lives, because the pseudo hunter did not take the chance of losing a possible advantage by waiting long enough to ascertain definitely what it was he saw over the sights of his rifle. In the seasons of 1909 and 1910, in five states not having a buck law, forty men were killed. In the three seasons, 1910 to 1912, in nine states having a buck law, no lives were lost from this cause.

Today in the greater portion of the big game territory of this country and Canada only horned game can legally be killed. It is hoped that the rule will soon become universal. In the sections where the law is in force the practical benefits are immediately apparent. Only when the supply becomes too large is there any excuse for even a temporary abandonment of the principle.

The American Museum and College Zoölogy

By J. H. McGREGOR

Associate Professor of Zoölogy in Columbia University, and Research Associate in Anthropology, American Museum of Natural History

AS a teacher of zoölogy in Columbia University the writer has, during the past few years, made increasing use of the exceptional facilities afforded by the American Museum of Natural History as an adjunct to regular class work. The following statement sets forth what these teaching facilities are and how they may be utilized. Of course the scope of the Museum's activities today is far broader than the field of natural history in the old restricted sense, but the present notes will be limited to the domain of zoölogy.

Until within the last two decades most zoölogical museums were little more than systematic collections of "specimens," stuffed skins and mounted skeletons of mammals and birds, alcoholic preserves of invertebrates and cold-blooded vertebrates, cases of insects, shells, and fossils, all duly labeled as to genus, species, and locality. Such collections are of value to the taxonomist and undoubtedly of considerable interest to the general public, but they really tell very little about any particular animal, except as regards its form and external features. It is true that the American Museum, even twenty years ago, was much more than such a mere collection of species, but especially during the last fifteen years the Museum has undertaken to show, not merely how animals appear in life, but their essentials of structure, their habits, relation to environment, and in many cases their life histories. Forms so mounted as to appear absolutely lifelike are exhibited in settings which simulate exactly their natural surroundings, and in many cases even microscopic organisms such as Protozoa, Rotifera, and Bryozoa are represented down to the finest details of structure, by greatly enlarged models marvelously wrought in glass and wax, and in some cases with their environment correspondingly magnified. The aim at present is, in short, to tell as much as possible about the animals and their ways of living.

The Museum avowedly performs a threefold function; first, the development of its *collections*, involving constant and extensive field work and exploration; second, *research*, as evidenced by the numerous volumes of "memoirs" and "bulletins" — the scientific staff is prolific in original investigations; and third, *education*. As a factor in popular education the rôle of the Museum is probably very generally realized, but its service in connection with the more technical college and university study of zoölogy, while no less real, is perhaps less generally appreciated.

In the first place should be mentioned the thoroughly cordial attitude of the Museum authorities. The President, the Director, and in the writer's experience all the officers of the Museum, not merely tolerate but welcome the use of the Museum facilities by students. In the case of Columbia University the coöperation has been especially close, as a number of men are connected with both institutions as professors and curators. In numerous cases researches by graduate students are based upon Museum material. Indeed, for some years the department of vertebrate

palæontology in the Museum has maintained a "Columbia room" and two of the University graduate courses in zoölogy (Evolution of Vertebrates and a course on Mammals) are given by Professor W. K. Gregory at the Museum entirely, owing to the fact that all the material used in these courses belongs to the study collections of the Museum. The proximity of the Museum thus renders the maintenance of a large University museum unnecessary, and the University department of zoölogy, consequently, has only a relatively small, although under the conditions ample, teaching collection.

In the personal experience of the writer, the Museum material is especially valuable in connection with a class in second-year zoölogy (to which a year of general biology and elementary zoölogy is prerequisite), a full year course in straight zoölogy, in which all the animal phyla, beginning with Protozoa and ending with mammals, are studied in lecture room, textbook, and laboratory. As a regular part of this course four visits to the Museum are made during the year. The first of these occurs after the Protozoa, sponges, cœlenterates, and flatworms have been studied, and is devoted to these groups as presented in the Darwin hall of the Museum. The students, having previously studied these forms in the laboratory, the Museum visit affords a valuable review, and in the case of a considerable number of forms which it is not practicable to study in the laboratory, enlarged models serve to elucidate their structure which otherwise would be known to the student only through descriptions and illustrations in books. Many persons are deficient in the ability to visualize or form any adequate image of structure in three dimensions from study of flat diagrams and pictures; in such cases these solid models prove to be most helpful.

As examples, may be cited the glass models of certain Radiolaria which show, in the clearest manner, not only the silicious skeleton but the protoplasmic structure, central capsule, and other structural detail. As a matter of fact the classes study prepared slides of radiolarian skeletons and stained total mounts and sections in the laboratory, but the beautiful tridimensional models, many of which are marvels of delicacy, give a new interest to the subject. The enlarged model of a portion of a millepore colony also illustrates the structure of a type which it is quite impossible to study satisfactorily from actual preserved material. The models showing the embryonic development of a stone coral, and others illustrating the method of secretion of the corallum and its relations to the soft parts in various corals are also studied with profit. Another series illustrating the essentials of structure of the various types of sponges, a group notoriously difficult to work out (with the exception of the simple calcareous forms), is in preparation and will prove very helpful.

A second session in the Darwin hall some weeks later is devoted to the study of the various worms, Rotifera, mollusks, and echinoderms.

In the spring term the life groups of lower vertebrates — the hagfishes, lampreys, lungfishes, the various ganoids [Who could forget the group of spoonbill sturgeons?], and the especially beautiful amphibian exhibits, the frog pool and the home of the hellbenders, are visited, and these are among the finest zoölogical preparations in the Museum. Attention is given to some of the more important fossil fishes such as the cladoselachid sharks with their primitive lateral fins, and the armored

Amphibia or stegocephalians, so noteworthy in the evolutionary history of land vertebrates.

Near the end of the college year a fourth Museum excursion is made, this time to the collections illustrating the morphology and evolution of the higher vertebrates — the reptiles, birds and mammals. The halls of fossil reptiles and mammals contain perhaps the rarest treasures of the Museum. Only a small number of these exhibits are considered with the college classes, but a few of the more important, notably the chief types of dinosaurs, the various orders of extinct marine reptiles with their remarkable adaptations to aquatic life, and the ancient toothed birds are examined. Of course, the famous gallery of avian life groups is visited.

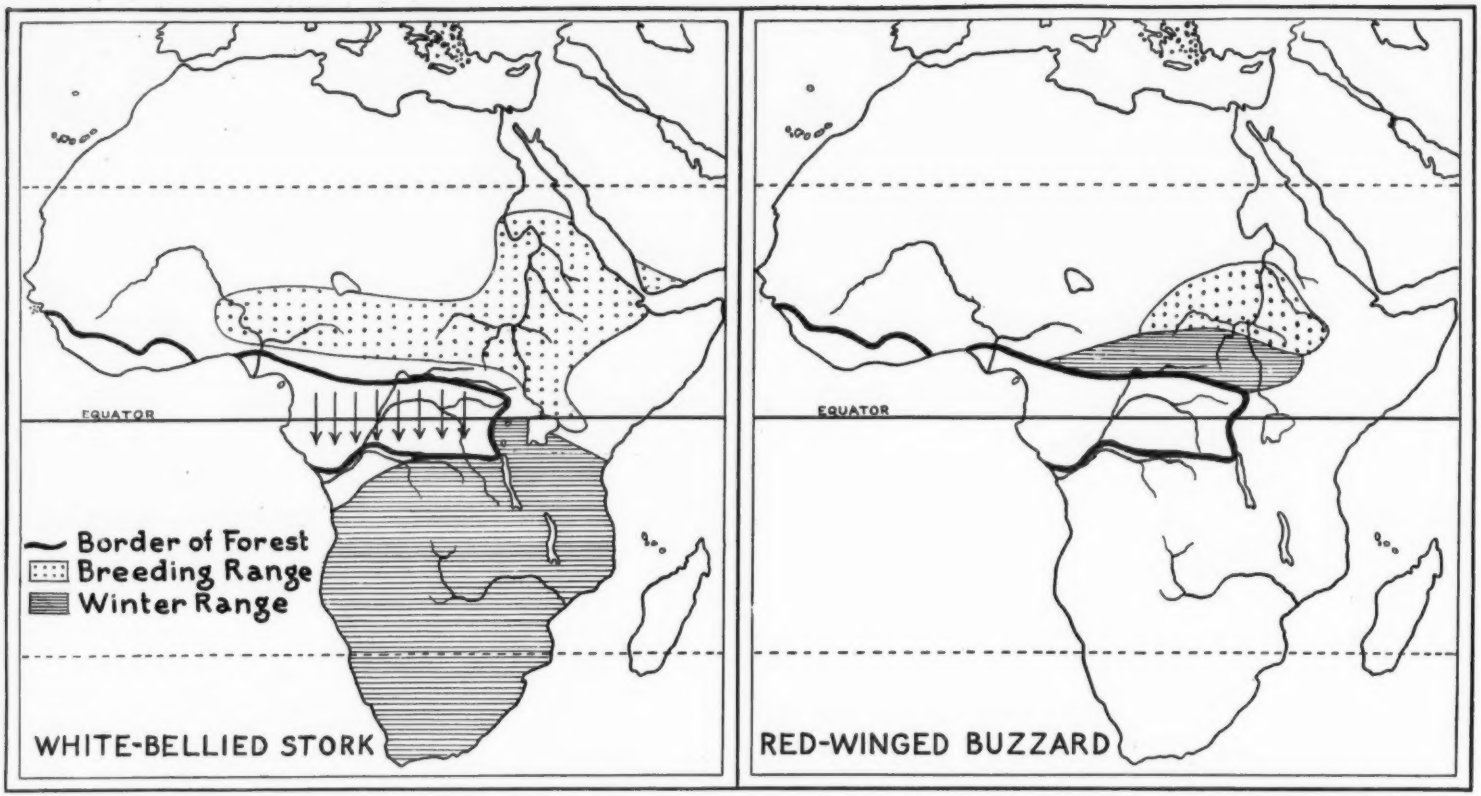
Among the exhibits of recent mammals, the whale gallery must be mentioned, as the adaptation of these creatures to fishlike habit is shown in many features which may be instructively compared with those of the swimming ichthyosaurs among the extinct reptiles. The exhibits of the evolution of the horse and of the elephants are also worth careful study; indeed, as material for the historic illustration of organic evolution, the teeth and feet of the horses rank among the classic examples. Instances of adaptation, in color, form and what not, are to be seen literally in almost every Museum case. As for species variation, special installations have been made to illustrate this in molluscan shells, birds and small mammals. Recently models have been made to illustrate the Mendelian principle in heredity in the classic case of the pea, and other models of a similar sort are in preparation.

In enumerating the aids to zoölogical study offered by the Museum, mention must be made of the special guide leaflets to various groups published from time to time. A number of these, as for example the one on the "Evolution of the Horse" are more than mere guides, are indeed excellent brief monographs, and are recommended to the students for careful reading.

Regarding the matter of guidebooks, the writer has sometimes wondered whether, in addition to the special guide leaflets, something in the nature of a general "students' guidebook" to the zoölogical exhibits might be practicable — a sort of systematic index to the more important illustrations of the structure, mode of life, and evolution of all the chief groups of animals, living and fossil.

Columbia University, owing to its relative proximity to the Museum and to the close relations between the scientific staffs of the two institutions, perhaps has enjoyed the benefits of the Museum somewhat more fully than have some of the other colleges in the city, but classes from other institutions, notably from New York University, the College of the City of New York and Hunter College, utilize the Museum in essentially the same manner as do the Columbia classes; and as for secondary and high school classes in zoölogy, any frequent Museum visitor must realize the extent to which these younger students avail themselves of its resources.

The writer feels sure that the zoölogy teachers of the city, whether engaged in high school, college, or university instruction, are unanimous in their appreciation of the fact that the American Museum of Natural History gives New York a great and unique advantage in zoölogical education.



Although it is one of the summer visitants to South Africa, the white-bellied stork does not nest there, but only north of the equator, in the Sudan, in Abyssinia, and southern Arabia, where it is found from March to September. The arrows indicate its subsequent migration southward across the Congo and Kamerun forests

The red-winged buzzard, fond of steppes and savannah, lives during the rainy season, April to October, on the White Nile. At the approach of the annual drought, it moves southward as far as the northern edge of the forest

Migration of Birds in Africa

By JAMES P. CHAPIN

THE many fascinating volumes that have been written on the travels of birds deal especially with those of the North Temperate and Arctic regions, and these migrations are beyond a doubt the most striking; but it is well known that certain species in the Southern Hemisphere have similar instincts. In the Argentine, in South Africa, and in Australia there are land birds that withdraw to the northward during the cold season; and some of the oceanic birds nesting on the islands of the southern seas migrate in the same direction. One among them, Wilson's petrel, is common even in our northerly latitude in July. Within the tropics, however, the comparatively uniform temperature throughout the year would seem to favor the development of sedentary habits, and this is generally agreed to be the case.

Nevertheless there is some change of season even close to the equator, where the continued heat and damp trade winds produce a moist and sultry zone known as the "equatorial calm belt," the "doldrums" of sailors. As a result of the inclination of the earth's axis, this belt is farthest north in July, and farthest south in January, hence at latitudes of five to twenty degrees there is a regular alternation of rainy and dry seasons of four to seven months each, and nearer the equator it is apt to rain throughout the year.

To these conditions West Africa owes its great rain forest, covering most of the shores of the Gulf of Guinea and the middle of the Congo basin. This forest is a factor of prime importance in the distribution of African birds; and the traveler in tropical Africa, almost without reflection, classifies them as water birds, forest birds, and plains or savannah birds. There are, to be sure, also mountain birds, but African mountain ranges are never long and high enough to act as effectual barriers.

To a savannah bird, on the other hand, this great forest, hundreds of miles wide, is a real obstruction, while the true bird of the forest seldom ventures far from its shade, and may even show a strong dislike for second growth. These forest birds, enjoying a perpetual rainy season, certainly have little reason to migrate, and indeed seldom do so. It is among the birds of "bushveldt" and plains, where drought reigns for part of the year, that we find the migratory instinct better developed. Some of these even cross the wide forest region on their journeys.

While considering the conditions in the equatorial region, we must not lose sight of those in South Africa. These conditions are admirably summed up in Mr. W. L. Sclater's paper on *The Migration of Birds in South Africa*, read in 1905 before the British Association in Johannesburg. Of the 814 species known from that region, 76 are migrants from Europe and Asia, 21 are "African migrants," coming in summer to South Africa, where most of them nest, and 49 others — "partial migrants" — are somewhat migratory, but are fairly numerous at all times of year in that territory. The 36 "island breeders" — all sea birds nesting on oceanic islands — are found on the South African coasts in winter.

Mr. Sclater's object was to stimulate the interest of South Africans, and to secure further information. Scores of white storks, banded in Germany, have been found in South Africa, where a few of this species sometimes remain throughout the year, but do not breed. The European bee eater does actually nest occasionally in South Africa, and the purple and gray herons, of the same species as in Europe, do so regularly.

Still more needed were observations from farther north, in central Africa, to show where the South African migrants "wintered." We find this already stated in 1892, in Charles Dixon's volume on *The Migration of Birds*. The fact that certain northern species, for example: Bonaparte's sandpiper, the eastern golden plover, the turnstone, the eared grebe, and the quail, were supposed to breed also in the Southern Hemisphere, led him to postulate a "neutral zone," not only in central Africa, but probably in Brazil and the Malay Archipelago as well, where certain species would be found throughout the year, yet never breeding; for some would go north to nest during the northern summer, and the remainder at the opposite season repair to the

southward to take advantage of the summer there.

The study of such questions necessitates long residence in a country. During our five and a half years together in the Belgian Congo, Mr. Herbert Lang and I enjoyed a golden opportunity for observations on the periodic movements of the birds, especially since we were always within a few degrees of the equator. Here, as in South Africa, in addition to the Palæarctic migrants, of which about one hundred and fifty kinds visit Africa, there was also a large number of African migrants, some of which breed south of the equator, but the greater number north of it.

It is worthy of mention that certain of the "northern migrants" are much more common in South Africa, than in the central parts, over which they pass hurriedly. It is surprising, too, how early some of them come south: we have seen white storks back in the Congo on July 18, and it is about a week later than this that the common sandpiper and European swift arrive. The two latter spend by far the greater part of their year in Africa, where they remain until April.

The greater number of the northern migrants arrives in central Africa in September and October, and includes many of the birds most familiar to Europeans, of which we can mention here only a few more: black terns, two species of snipe and many other shore birds, three species of harrier, the honey buzzard, kestrels, osprey, cuckoo, roller, swallow, sand martin, house martin, spotted and pied flycatcher, whinchat, nightingale, redstart, willow warbler, shrikes, wagtails, tree pipit, and oriole.

We made also a rough classification of migrants in the field. In the Uele District, for example, just on the northeastern border of the forest, this included about fifty-five northern migrants, and thirty-five regular African migrants, not counting birds of irregular occurrence — "partial migrants" — whose numbers are difficult to fix definitely. These were not the same birds that Sclater had reported as leaving South Africa in the winter, for most of them came to this district, just north of the forest, to spend the dry season, which falls approximately in the same months (December to April) as the summer in South Africa. Of all the species cited by Sclater as African or partial migrants, only ten were noted by us as at all migratory in the Uele.

This reappearance of certain birds at stated seasons is well known to the black inhabitants of the northeastern Congo, who speak of such birds, in Bangala, the trade dialect, as *Ndeke na gala*, meaning literally "birds of the dry season." There are a few, however, that come here to spend the rainy season, or parts of it. Great regularity is shown by the African migrants in their arrival and departure. They do not await the annual burning of the grass, but generally make their appearance earlier, nor do they all come and go together. Each species has its own calendar. This we were able to verify during the three dry seasons spent at the northern edge of the forest.

Even such observations as these need confirmation and completion from other regions by other observers; only in this way can definite results be secured. Great assistance can be drawn from books and papers containing records of various species with dates. The notes of von Heuglin on birds of the upper Nile region have proved especially helpful, and the articles in the *Ibis* by Mr. G. L. Bates, who has lived so many years in the southern Kamerun, are full of valuable information. Mr. Sclater, in South Africa, and other observers in many different parts of the continent, have published notes of extreme interest, for they enable us to draw definite conclusions from our own experience. The key to the problem is a knowledge of the seasons at which each species is on the move.

We have now proceeded far enough with this task to be able to point out, in some of these African migrations, where the birds breed, when and how far they go afterward, and in a general way what weather they encounter in the various regions.

One of the migrants which visits South Africa in summer, but, unlike most of its comrades, does not nest there, is the white-bellied stork (*Abdimia abdimii*). We found this bird to be one of the few of Sclater's African migrants that is also transient in the upper Congo. There are two seasons when it is seen — often in great flocks, which circle in a huge vortex high overhead. These are: (1) March and April, (2) October and November. Notice how all this fits nicely together. Looking through the literature, we find that storks of this species have been

discovered nesting only north of the forest belt, from northern Nigeria to Abyssinia, and Aden in southern Arabia, southward to British East Africa. In this area they are found from March to September, building nests in colonies on trees or even on roofs, like the white stork of Europe.

Then comes the great migration already noticed, which obliges numbers of them to cross the Congo forest, where they can find food only in the scattered clearings made by man. Others avoid the forest by going through East Africa, and many reach Cape Colony, their wanderings thus taking them farther south of the equator than their breeding range lies north of it. They nest, then, during the rainy season to the north, and enjoy the rainy months, or summer, in southern Africa.

One of the common birds to invade the Congo every year in late October, and which I took at first for a visitor from Asia, is the white-necked bee eater (*Aerops albicollis*). Abundant, not only in the more open districts but also about clearings in the forest, these bee eaters often gather in large noisy flocks, especially toward evening. At this season they even extend out into the savannah country south of the forest, but do not breed.

Bates reports that they spend the months from November to April in the Kamerun, and there are records at this season from as far west as Senegal. In the northeastern Congo they remain regularly till early June, and I have known them to stay in the Uele till as late as June 15.

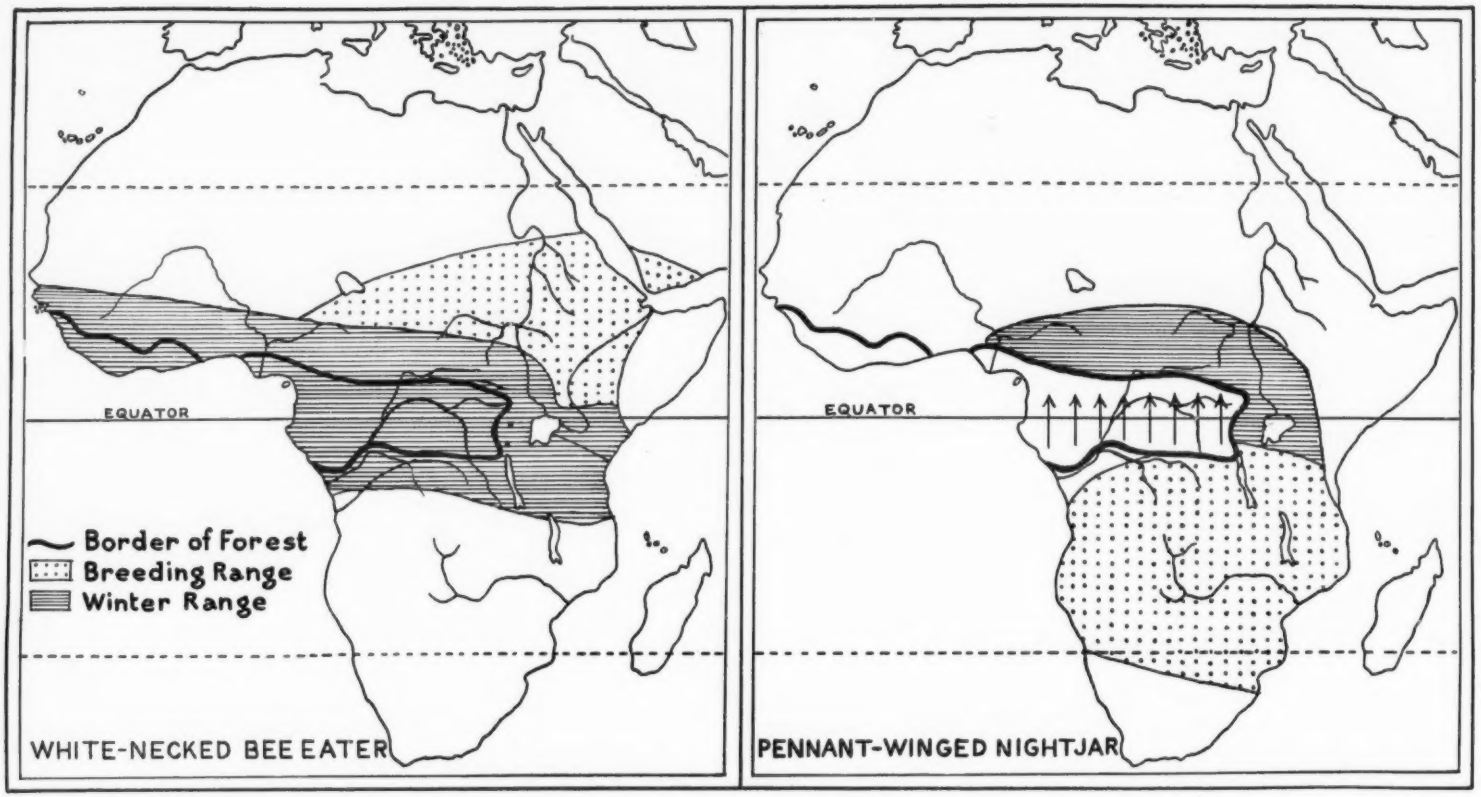
The breeding range of the species, to which they now betake themselves, extends from the Sudan to Abyssinia and southern Arabia, southward in Africa to Uganda. To this territory they are confined through most of the rainy season — that is from July to September — after which they again return southward, and many cross the equator. The northern limit of the breeding range is close to latitude 20° N., the southern edge of the "winter" range about latitude 10° S. Those which stay in the forested territory do not suffer from drought, and south of this they find the rainy season in progress.

The white-necked bee eater is not held back by the Congo forest; but the greater number of the Sudanese birds which come south to the Uele for the dry season do not usually go beyond the border of the savannah. It is often said that birds in the tropics prefer to breed in the rainy season, but this rule has many exceptions. Among these birds visiting the Uele in the dry season, a number nest regularly — for example, a large bustard (*Otis denhami*), a nocturnal plover (*Oedicnemus senegalenis*), a wattled lapwing (*Lobivanellus senegallus*), a buzzard (*Buteo auguralis*), a gray hornbill (*Lophoceros nasutus*), a hoopoe (*Upupa senegalensis*) a beautiful kingfisher (*Halcyon senegalensis*), the standard-winged nightjar (*Macrodipteryx macrodipterus*) and a sunbird (*Hedydipna platura*).

Others do not nest while in the Uele. As an example of this we may take the red-winged buzzard (*Butastur rufipennis*), a bird of prey feeding mainly on grasshoppers — often captured on the wing before an advancing bush fire, which attracts many other birds, such as kites, swallows, and beautiful rosy bee eaters. This buzzard is common in the Uele from November to the end of March, and has been collected at the same season as far west as northern Kamerun. To breed, however, it goes northward in April to the White Nile, as far as Khartoum, where Mr. A. L. Butler has observed that it disappears in October.

So far the migrants considered have all been birds that nest north of the equator. One of the best instances of a species which breeds south of the equator and migrates north to the Sudan is the pennant-winged nightjar (*Cosmetornis vexillarius*). The male is a striking bird with long narrow plumes waving out behind its broad wings, and we found that both males and females cross the forest belt each year in February and March, after which they become common in the savannah country to the northward.

In July and August however, they take their departure again, without having laid eggs, and at this season they are again to be seen at dusk about villages in the forest, or aroused from their slumbers in the daytime, on the ground in clearings or open swampy spots. They are on their way south, for they breed in September, October, and November, from Angola and Lake Tanganyika to Damaraland and the Transvaal. Many of Sclater's South African migrants may be compared with this bird, though they range for the most part, while breeding, farther south, and do not travel so far northward.



During its breeding season, from July to September, the white-necked bee eater is restricted to the more arid northern section of tropical Africa; but when once its young are fledged, it extends the range to the southward, across all the equatorial forest, to Nyasaland and Angola beyond

In all three preceding cases, nesting took place north of the equator, but the pennant-winged nightjar chooses to lay its eggs only in the southern savannah, from September to November (the early rainy season). Starting northward in February, many cross the broad rainy forest belt, and visit the northern savannah between March and August

All of these birds cited as examples are common and conspicuous, easily observed, and could not have passed unnoticed had they been resident throughout the year. The white-bellied stork, white-necked bee eater, red-winged buzzard, and pennant-winged nightjar offer four clear-cut examples of migration within the tropics. Some of the species, however, which we found to be migratory in the Uele, are distributed over all the more open parts of Africa, and to judge from the dates at which they have been taken in various regions do not migrate north and south in this way.

The common yellow-billed kite (*Milvus ægyptius*) is a perplexing case. In the forest belt it is never common; the carrion insects, and other weak prey on which it feeds are not easy for it to find; but a stray individual may be seen in almost any month. On rare occasions large flocks are seen passing over. In the Ituri we have noticed them going southward in August. In the savannah districts just north and south of the forest belt they are very abundant in the dry season, but practically absent in the rainy months. As these seasons alternate to the north and south, we might jump to the conclusion that the kites simply migrate across the forest like the pennant-winged nightjar. Such does not appear to be the case, however, for in many parts farther removed from the equator, both north and south, they are found throughout the year. Moreover, at the very limits of their range, they are present only in the summer (rainy season). At the same period then, when they increase in numbers just north of the forest, they are likewise invading South Africa in flocks, and conversely, at the season when they gather about grass fires just south of the forest they are also increasing in numbers in Senegal and visiting the islands of the eastern Mediterranean. Their movements thus seem to be correlated from north to south, but no large body of kites migrates from South to North Africa, and they nest everywhere save in the equatorial forest.

The cattle heron (*Bubulcus ibis*) is another bird of wide distribution, from southern Europe and central Asia to South Africa and Madagascar. But the cattle herons of the northeastern Congo act like northern migrants, arriving in late October and November, when, according to plumage and other indications, they have finished nesting. Toward January they are rare, as though they had continued farther south, but by April they are again numerous, and vanish regularly before the middle of May, after some of them have assumed the buff plumes of the nuptial dress.

Bates also writes that they are seen in the Kamerun in November and in May. These birds must breed in Africa, farther north; but others of the species are known to breed in the south, where they are not considered migratory.

This is a case like those which caused Dixon to suspect a neutral zone of "wintering" or non breeding birds in central Africa. But in some instances at least, as the quail and bittern, the South African birds have been found to be distinct from the European, subspecifically at least. As far as I have seen, there is no such neutral zone in the Congo. If such a zone did exist, in the case of the cattle heron, it would have to be south of the equator, but the cattle herons of South Africa are not known to migrate at all.

Migration, then, although less characteristic of birds in the tropics, does take place not only among birds of temperate South Africa, but also even among many that nest within ten degrees of the equator. These movements are regular, like those of more northern birds, and are probably due to variation in the food supply, governed of course by seasonal changes — here rains and drought rather than heat and cold. In the case of the pennant-winged nightjar, the migration may insure a bountiful diet of winged termites (a favorite food of this and many other birds), since these insects fly in the greatest numbers toward the beginning of the rainy season. But whatever its causes, we have still a great deal to learn of the simple facts of bird migration on the great African continent.

Seasonal journeys, even in the northeastern Congo, are by no means restricted to birds. In the Ituri District several species of butterflies are seen traveling northward in enormous numbers at definite seasons, and the common yellow-necked fruit bat (*Eidolon helvum*) seems to have some similar habit. In the northeastern Uele even the elephants go northward into the savannah during the rainy months, and retire again to the border of the forest on the approach of the dry season.

Museum Notes

SINCE the last issue of the JOURNAL the following persons have become members of the Museum:

Benefactor, DR. JAMES DOUGLAS.

Life Members, DR. IRA OTIS TRACY, and MESSRS. S. PRENTISS BALDWIN, HENRY MCC. BANGS, LOUIS J. EHRET, JOHN H. LOVE, M. TAYLOR PYNE, FINLEY J. SHEPARD, IRVING K. TAYLOR, and A. VAN CORTLANDT.

Sustaining Members, MRS. H. B. DURYEA, MRS. ISAAC N. SELIGMAN, and MRS. P. A. VALENTINE.

Annual Members, MRS. J. K. BURKE, MRS. R. L. FOWLER, JR., MRS. THOMAS POWELL FOWLER, MRS. G. MAURICE HECKSCHER, MRS. C. R. HUDSON, MRS. WALTER LEWISOHN, MRS. DANIEL GRAY REID, MRS. E. S. REYNAL, MRS. C. L. F. ROBINSON, MRS. FRANCIS ROGERS, MRS. WM. N. SHAW, MRS. A. F. SCHAUFFLER, MRS. HENRY W. SAGE, MRS. C. M. ROOME, MRS. EDWIN THORNE, MRS. J. W. THORNE, MRS. MAXIMILIAN TOCH, MRS. CHAS. WEISS, MISSES ROSIE BERNHEIMER, and K. C. ROCKWOOD, DR. J. R. FABRICIUS, DR. MAX WALLERSTEIN, and MESSRS. JULIUS OCHS ADLER, COPLEY AMORY, JR., HENRY DE FOREST BALDWIN, HENRY S. BOWERS, JOHN MCE. BOWMAN, NEWCOMB CARLTON, LEOPOLD DEMUTH, MAX EISMAN, EDWIN FRANKENSTEIN, WILLIAM H. GELSHENEN, ALBERT GOLDMAN, RUDOLPH GUITERMAN, THEO. HETZLER, GEORGE CLAY HOLLISTER, ELKAN HOLZMAN, FRANCIS T. HOMER, EDWIN C. JOHNSTON. ROBERT B. KNOWLES, FRANK E. LAW, WILLIAM M. LYBRAND, VICTOR K. MCELHENY, JR., ROBERT J. MASBACH, GEORGE O. MAY, PAUL PIEL, A. W. POPPER, AUGUSTE RICHARD, MONROE D. ROBINSON, ALFRED ROELKER, JR., WILLIAM J. ROOME, CHAPMAN ROPES, EDWARD L. ROSENFELD, HENRY SCHAEFER, A. H. SCHEFER, CARL SEEMAN, ARTHUR L. SOLOMON, VICTOR SUTRO, RODERICK TERRY, JR., CHAS. WANNINGER, LOUIS WÄTJEN, EMIL WEIL, THEODORE WERNER, and M. A. WESENDONCK.

IN connection with the death of Mr. Seth Low on September 17, 1916, the trustees of the American Museum at their recent meeting unanimously adopted the following resolution: In the death of Mr. Seth Low, the American Museum has lost one of the most distinguished of the many public-spirited and large-minded citizens who have served the interests of the institution during the past half century. Mr. Low's name followed that of Abram S. Hewitt, as a former mayor of the city, who gave of his valuable time and experience to the upbuilding of our great institution. As president of Columbia University in 1901, he was the first great educator to recognize that the University should not duplicate the work of the Museum, but should send its students here for their advanced practical studies and researches. This union has led to the training of many men who are fast becoming eminent in several fields of natural history. He first served the Museum on the East Asiatic Committee, with Messrs. Hill, Harriman, Dodge, and Schiff. Elected a trustee May 5, 1905, he served on the Nominating Committee, the Jesup Memorial Committee, the Executive Committee, the Committee on the Museum for the Blind, the Committee on Investigation of Museum Administration, and the Auditing Committee. To each he gave his valuable time and rare judgment in public affairs. During the eleven years of his life as trustee, he never hesitated when opportunity offered to show his intense interest in the public welfare, and his faith in the great public educational work which the Museum is undertaking.

A NEW guide book dealing with all the scientific museums of Greater New York and entitled *A Guide to the Nature Treasures of New York City*, has just been published by the American Museum. It is designed to provide under one cover and without necessitating undue expenditure of time, an indication of the city's resources along natural history lines, at the same time entering into sufficient detail to arouse interest in the exhibits and to enable the student of any particular branch or subject to know what he may find and where. The book is profusely illustrated and provided also with maps, plans, and full directions for transit. It deals with the American Museum of Natural History, the New York Botanical Garden, the New York Zoölogical Park, the New York Aquarium, the Museum of the Brooklyn Institute, the Children's Museum, Brooklyn, and the Brooklyn Botanic Garden, and has been prepared by Mr.

George N. Pindar, of the American Museum, with the courteous collaboration of the directors and staffs of this and the other institutions concerned. The cover of the book has been designed by Mr. Albert Operti of the American Museum.

As a result of Dr. Frank M. Chapman's expedition to South America, material was obtained at Chimborazo for a large panoramic faunal group of that region. With the assistance of Mr. George K. Cherrie a splendid collection of birds was obtained on the tableland at an altitude of one hundred and twenty-five thousand feet. A trip from Lake Titicaca to Cuzco, down the valley of the Urubamba, was taken under the joint auspices of the American Museum, Yale University, and the National Geographic Society, for the purpose of making an ornithological survey of this region. At Mendoza, in the Argentine, Dr. Chapman made connection with Messrs. Leo Miller and Howarth Boyle, who had been two years in the field securing a superb collection consisting of nine thousand birds and fifteen hundred mammals. Material was obtained at Mendoza for a group of rheas of the western Argentine plains. From Rio, in Brazil, a short trip was made to the Organ Mountains, where a collection of three hundred and fifty birds was secured.

In appreciation of his valuable services in bringing together the superb collection of North American woods forming the Jesup Collection, and also of his scientific contributions to silviculture, a bronze bust of Professor Charles S. Sargent has been ordered by the trustees to be placed in the forestry hall of the American Museum. The bust is to be executed by the well-known sculptor S. C. Pietro, to whom is to be attributed the bust of John Burroughs — a copy of which, now in the bird hall, was presented to the Museum by Mr. Henry Ford. A bust of John Muir, by the same artist, presented to the Museum by Mrs. E. H. Harriman, will occupy a position in the forestry hall as a companion to the bust of Professor Sargent.

Mr. Charles Robert Knight will hold an exhibition of his models and paintings of modern animals in the west assembly hall of the American Museum from December 15 to January 15; also at the same time a first view of his new mural decoration of prehistoric animals, in the hall of the age of man on the fourth floor. This mural, nine feet by fifty feet in size, shows a herd of reindeer and a herd of mammoths — two of the most notable animals of the period when the cave man flourished. The canvas has been executed with unusual power.

Mr. Roy Chapman Andrews, in charge of the American Museum's Asiatic zoölogical expedition, writing from Li-chiang fu, Yunnan Province, China, on October 7, reports the expedition as on the way to the Thibetan frontier, in the neighborhood of which collecting will be done until snow fills the passes. Owing to unfavorable reports from Kiuchau the expedition will confine operations to Yunnan Province, where the high Thibetan fauna in the north and the tropical Burma and Tonking fauna in the south promise rich results. Except for the little work done by the Anderson expedition in 1875, this province is practically a new field zoölogically, and at the time of writing, after twenty days continuous riding into the interior, the Museum expedition was encamped in country where no other zoölogist had ever been and where the indications for collecting were exceedingly favorable. A fine series of *tupaia* and two panda skins were obtained in the first three days among 112 specimens, and serow, goral, wapiti, bear, and leopard were reported in varying numbers on a neighboring mountain, eighteen thousand feet high. All members of the expedition were reported well.

Prof. Henry Fairfield Osborn, chairman of the Local Committee, has appointed the following Honorary Reception Committee of the City of New York, in connection with the meetings of the American Association for the Advancement of Science: His Honor, John Purroy Mitchel, Elmer Ellsworth Brown, Nicholas Murray Butler, Andrew Carnegie, Joseph H. Choate, R. Fulton Cutting, Cleveland H. Dodge, Henry C. Frick, James B. Ford, A. Barton Hepburn, George G. Heye, Archer M. Huntington, Walter B. James, V. Everit Macy, Emerson McMillin, Sidney Edward Mezes, Mrs. Henry Fairfield Osborn, M. I. Pupin, Theodore Roosevelt, Mrs. Willard D. Straight, Mrs. Frederick Ferris Thompson, and Frederic C. Walcott.

The opening general session of the American Association for the Advancement of Science will be held in the Auditorium of the Museum on the evening of Tuesday, December 26, at 8 o'clock. Dr. Charles R. Van Hise, President of the University of Wisconsin, will preside, and Dr. William Wallace Campbell, Director of Lick Observatory, will give the address of the retiring president, on "The Nebulæ."

From 9.30 to 11:00 o'clock in the hall of the age of man, the Honorary Reception Committee will tender a general reception to Presidents Campbell and Van Hise and the members of the American Association for the Advancement of Science and of affiliated societies.

THROUGH the generosity of Messrs. Alessandro and Ernesto G. Fabbri, of New York City, with the coöperation of the department of ichthyology of the American Museum, the JOURNAL for this month is able to publish the color plate accompanying the article "The Problem of Bright-colored Fishes." The plate was designed from specimens in the Museum and aims to show the brilliant colorations of certain fishes which live in the protection of coral reefs.

A SERIES of one hundred picture stamps illustrating some of the more interesting exhibits, and a souvenir album to contain them has just been published by the American Museum and may be obtained at the door. It is hoped that these stamps, besides furnishing visitors with a souvenir of the Museum, will have value as an educational medium especially for children. The album, which contains places for inserting all the stamps, with a printed legend under each place, is sold with the first set of ten stamps for fifteen cents. Succeeding sets of ten stamps cost each ten cents and each stamp is to be placed over its appropriate legend in the book. The pictures have been well chosen and the text carefully prepared and phrased in simple language which children can understand.

IT IS of interest to all scientists of the New World that the Argentine Society of Natural Sciences of Buenos Aires, which publishes the review, *Physis*, is planning a series of national reunions to take place every two years, each time in a different city of the Argentine. It is intended that these reunions shall be similar in character to those of the British Association for the Advancement of Science, and the French and American associations; they will be the first assemblies of their kind to convene in South America. The first reunion was held at Tucuman in the last week of November, 1916, in commemoration of the first centenary of the declaration of independence of the Argentine Republic in 1816. Tucuman is an important northern city, with a population of more than one hundred thousand, and with a University and natural history museum. The environment gave opportunities for interesting field excursions for the different sections during the meeting. Professor Angel Gallardo, director of the Museum of Buenos Aires, was president of this first national reunion, with the Minister of Public Instruction, president of honor. The papers which were presented, are to be bound in one volume with the report of the session.

BY purchase from Don Pedro Jose Rodericguez, through Mr. Luis Geronimo Martinez, of Brooklyn, the Museum's anthropological department has acquired a large collection of pottery figures and heads, taken from a series of mounds at Las Matas, near Maracay, Venezuela. These mounds, of which there are about thirty, each ten or twelve feet high and two or three hundred feet long, are near the banks of Lake Valencia, the site of a village probably belonging to lake-dwelling Indians. They contain pottery and urn burials and appear to afford an excellent opportunity for stratigraphical investigation, with a view to obtaining a cross section of the ancient history of Venezuela.

MR. ERNEST INGERSOLL, of the National Association of Audubon Societies, has recently completed and published a complete index to *Bird Lore*, the illustrated bimonthly magazine, edited by Dr. Frank M. Chapman, and devoted to bird study and bird protection.

The American Museum of Natural History

Seventy-seventh Street and Central Park West, New York City

Open free to the public on every day in the year.

The American Museum of Natural History was established in 1869 to promote the Natural Sciences and to diffuse a general knowledge of them among the people. It is dependent upon private subscriptions and the fees from members for procuring needed additions to the collections and for carrying on explorations in America and other parts of the world. The membership fees are,

Annual Members	$ 10	Patrons	$1,000
Sustaining Members (annually)	25	Associate Benefactors	10,000
Life Members	100	Associate Founders	25,000
Fellows	500	Benefactors	50,000

Guides for Study of Exhibits are provided on request to members and teachers by the department of public education. Teachers wishing to bring classes should write or telephone the department for an appointment, specifying the collection to be studied. Lectures to classes may also be arranged for. In all cases the best results are obtained with small groups of children.

The Museum Library contains more than 60,000 volumes with a good working collection of publications issued by scientific institutions and societies in this country and abroad. The library is open to the public for reference daily — Sundays and holidays excepted — from 9 A. M. to 5 P. M.

The Technical Publications of the Museum comprise the *Memoirs*, *Bulletin* and *Anthropological Papers*, the *Memoirs* and *Bulletin* edited by J. A. Allen, the *Anthropological Papers* by Clark Wissler. These publications cover the field and laboratory researches of the institution.

The Popular Publications of the Museum comprise the JOURNAL, edited by Mary Cynthia Dickerson, the *Handbooks*, *Leaflets* and *General Guide*. The following list gives some of the popular publications; complete lists, of both technical and popular publications, may be obtained from the Librarian.

POPULAR PUBLICATIONS

HANDBOOKS

NORTH AMERICAN INDIANS OF THE PLAINS. By Clark Wissler, Ph.D. *Paper, 25 cents; cloth, 50 cents.*

INDIANS OF THE SOUTHWEST. By Pliny Earle Goddard, Ph.D. *Paper, 25 cents; cloth, 50 cents.*

ANIMALS OF THE PAST. By Frederic A. Lucas, Sc.D. *Paper, 35 cents.*

DINOSAURS. By W. D. Matthew, Ph.D. *Price, 25 cents.*

ILLUSTRATED GUIDE LEAFLETS

GENERAL GUIDE TO THE COLLECTIONS. New edition issued August, 1916. *Price, 25 cents.*

THE COLLECTION OF MINERALS. By Louis P. Gratacap, A.M. *Price, 5 cents.*

NORTH AMERICAN RUMINANTS. By J. A. Allen, Ph.D. *Price, 10 cents.*

THE ANCIENT BASKET MAKERS OF SOUTHEASTERN UTAH. By George H. Pepper. *Price, 10 cents.*

PRIMITIVE ART. *Price, 15 cents.*

THE BIRDS OF THE VICINITY OF NEW YORK CITY. By Frank M. Chapman, Sc.D. *Price, 15 cents.*

PERUVIAN MUMMIES. By Charles W. Mead. *Price, 10 cents.*

THE METEORITES IN THE FOYER OF THE AMERICAN MUSEUM OF NATURAL HISTORY. By Edmund Otis Hovey, Ph.D. *Price, 10 cents.*

THE HABITAT GROUPS OF NORTH AMERICAN BIRDS. By Frank M. Chapman, Sc.D. *Second edition issued May, 1916. Price, 25 cents.*

THE INDIANS OF MANHATTAN ISLAND AND VICINITY. By Alanson Skinner. *Price, 20 cents.*

TREES AND FORESTRY. By Mary Cynthia Dickerson, B.S. *A new edition in course of preparation.*

THE PROTECTION OF RIVER AND HARBOR WATERS FROM MUNICIPAL WASTES. By Charles-Edward Amory Winslow, M.S. *Price, 10 cents.*

PLANT FORMS IN WAX. By E. C. B. Fassett. *Price, 10 cents.*

THE EVOLUTION OF THE HORSE. By W. D. Matthew, Ph.D. *Price, 20 cents.*

MAMMOTHS AND MASTODONS. By W.D.Matthew, Ph.D. *Price, 10 cents.*

HOW TO COLLECT AND PRESERVE INSECTS. By Frank E. Lutz, Ph.D. *Price, 10 cents.*

OUR COMMON BUTTERFLIES. By Frank E. Lutz, Ph.D., and F. E. Watson. *Price, 15 cents.*

THE BIG TREE AND ITS STORY. *Price, 10 cents.*

REPRINTS

THE GROUND SLOTH GROUP. By W. D. Matthew, Ph.D. *Price, 5 cents.*

THE WHARF PILE GROUP. By Roy W. Miner, A.B. *Price, 5 cents.*

THE SEA WORM GROUP. By Roy W. Miner, A.B. *Price, 10 cents.*

THE ANCESTRY OF THE EDENTATES. By W. D. Matthew, Ph.D. *Price, 5 cents.*

HEREDITY AND SEX. By Frank E. Lutz, Ph.D. *Price, 10 cents.*

Photo by A. G. Mayer

MOST NORTHERLY NATURAL GROVE OF PALMETTOS IN AMERICA

It is remarkable how abundant and well-conditioned a plant or animal may be at the extreme limit of its range — as seen in the most northerly of the world's coral reefs off Beaufort, North Carolina; the most northerly appearance of the scallop shell in Provincetown Harbor, Cape Cod; — also as shown in the most northerly growth of palmettos on Smith Island, Cape Fear, North Carolina, where the Gulf Stream flowing close along the shore imparts to this lonely place the last lingering spirit of the tropics

— See "The Gulf Stream Off Our Shores," p. 501